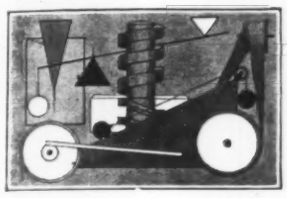
MACHINE DESIGN

as it affects

ENGINEERING–PRODUCTION–SALES

Volume 4 July, 1932 Number 7



Forthcoming ISSUES

ENGINEERS charged with responsibility for design being particularly interested in patents and patent law, MACHINE DESIGN *is planning to publish in forthcoming issues a comprehensive series of articles dealing with the various phases of this subject.*

The author of this series has been selected with infinite care. He is an authority whose experience in and close contact with the patent field places him in an excellent position to prepare a series of inimitable quality and value.

L. E. Jermy

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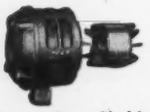


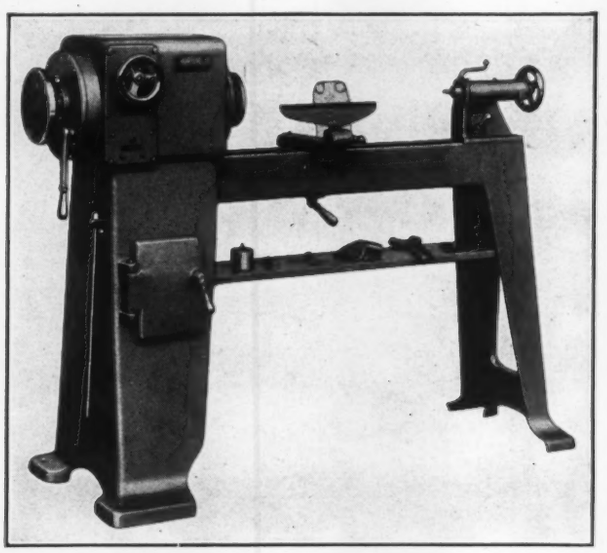
Frame Type Shaftless

Rolled Shell Shaftless

Arbor Type

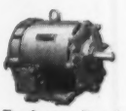
Pipe-Ventilated

Self-Cleaning



Lathe of well-known make equipped with specially designed Louis Allis headstock motor, control, and brake unit shown below.

Totally Enclosed Fan-Cooled



Explosion-Proof

Wound-Rotor

Direct Current

Head-Stock Type

Vertical

Flange-Mounted

Torque Type

Hoist Type

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SINCE 1901

STANDARD AND CUSTOM BUILT MOTORS

THE LOUIS ALLIS CO. MILWAUKEE, WIS.

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EVERY engineer responsible for the design of machines recognizes the value of manufacturer's catalogs and other trade literature. In many cases these booklets contain important data that cannot be found elsewhere. Often the designer's task is simplified if he has available an extensive supply of literature.

Machine Design lists and reviews trade publications in all fields important to the designer. The section is entitled "Manufacturers' Publications" and appears in this issue on page 70. Publications listed in this section may be obtained without charge from the manufacturers or through Machine Design.

HERE IT IS . . .
LINCOLN "Shield Arc" WELDER
THE NEW
LINCOLN
"Shield-Arc"
WELDER

MACHINE DESIGN
THE JOHNSON PUBLISHING COMPANY, CLEVELAND, OHIO
July, 1932 Vol. 4—No. 7

Adapting Parts To Accomplish Multiple Functions

By Benjamin R. Carson
R. C. A. Victor Co. Inc.

DEVELOPMENT of parts which have a number of different functions permits economical manufacture, inasmuch as the equipment may be fabricated with a minimum number of parts and a consequent minimum in tool and production costs. This principle has been followed consistently in the design of an automatic phonograph record changing device, Fig. 2. The duty of the entire mechanism is to play automatically and continuously 10-inch and manually both the 10 and 12-inch records.

Many important features in addition to the requirement of few parts had to be incorporated in the design for greatest utility in the finished equipment: The instrument has to be foolproof in principal, design and operation as no percentage of failure is permissible; and records had to be protected so that they would not be defaced, even if placed in a precarious position.

Included with these specifications were the re-

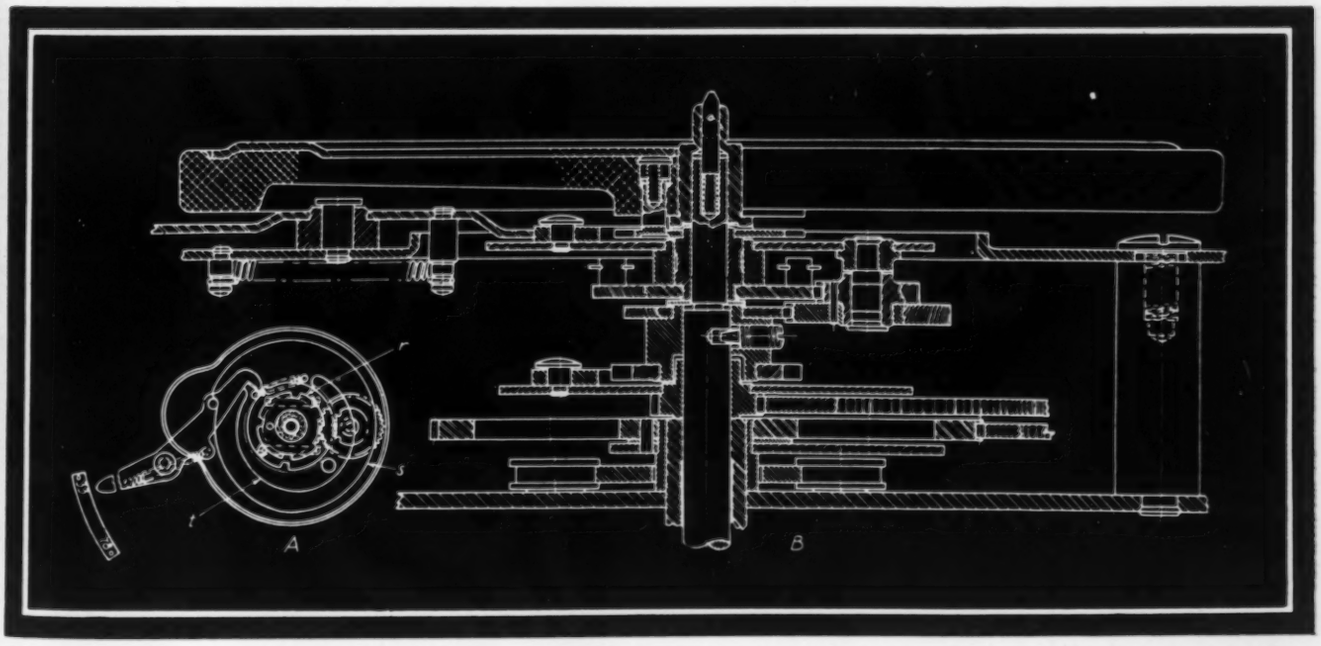

Fig. 1—A—Plan view of ratchet planetary gear two-speed device. B—Helical gear is pinned to driving ratchet hub for driving long playing record mechanism used in connection with new type records

Fig. 2—Instrument in playing position. Suspension arm feeding toward eccentric groove

quirements that the device had to be designed for the smallest possible cabinet space and as a unit for a line assembly that included adjustment, placing in the cabinet, testing and making ready for shipment. The magazine must be accessible for loading and unloading records at all times and the suspension arm free to rotate in either direction when the device is set for manual operation, like an ordinary phonograph. When changing records, the needle has to raise vertically before any rotation of the suspension arm and after the change, accurately descend to the record, with the needle between the outer edge and the first music groove. From this position it is fed positively into the groove.

Movements of the mechanism are controlled by a slide and slide saddle, *a*, Fig. 3 *X* as they actuate a series of levers and cams and are themselves controlled by a semi-circular cam put into operation at the completion of the playing of a record. The suspension arm initiates these movements. At the end of the music grooves in a record there is either an eccentric or a spiral groove having a pitch much greater than the music groove pitch. When the needle reaches the eccentric groove, the reverse movement of the suspension arm trips the mechanism, immediately starting the record changing cycle.

In this cycle, the suspension arm raises, then revolves to a position of rest. Record elevators rise to the record on the turntable and elevate it to a suitable height for magazine clearance. The magazine turns to a position directly over the turntable and under the elevated record, and when it is in this position the support of the elevators is removed from the record and it drops into the magazine. With the magazine returning to its original position, the bottom record is contacted by a transfer lever and pushed from the magazine to the turntable, guided by a spring pin in the spindle nose and the integral guide on the magazine. Elevators then descend to a position clear of the record and turn inwardly to a position where they can contact the record on the turntable when they again rise. Finally, the suspension arm turns to its proper position and descends until the needle contacts the record. As soon as this is done, the needle is pushed slowly into the first music groove.

Returning to the suspension arm where these movements start, and analyzing the movements, the arm when in playing position is moved through an arc in a clockwise direction by the music groove on the record, and lever *e*, Fig. 3 *X*, being fixed to the suspension arm swivel shaft, received a similar motion, bringing the attached trip pawl into mesh with ratchet teeth located on lever *b*. The counter clockwise motion of the arm when it reaches the eccentric groove creates a toggle at the pawl bearing which forces the ratchet on lever *b* forward, breaking contact between this lever and pawl *h*. During the playing of the record, there is no connection between the changing mechanism and the driving force.

Pawl Tooth Connects Device

The rotating members of the mechanism are mounted on bearings outside of the drive shaft and during playing of record receive no impetus from it. When the contact between lever *b* and pawl *h* is broken, the spring connecting the pawl and cam *i* brings the fixed tooth on the pawl into engagement with one of the special teeth on the turntable spindle, thus connecting the record changing mechanism to a power source.

This action starts the rotation of cam *i* which

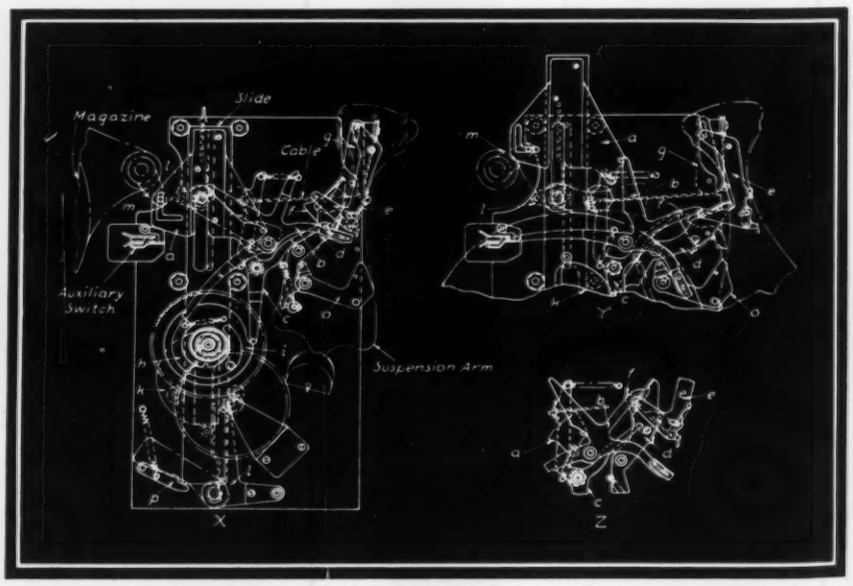

Fig. 3—X—Arrangement of parts in mechanism during playing of records. Y—Half through the cycle with slide at extreme end of travel. Z—Controlling parts for feeding needle into first music groove

drives through a gear train having a ratio of 28:1 a semicircular cam, *k*, which exerts a driving force against the roller on the slide and starts its backward motion. Slide saddle *a*, contacting levers *b* and *c* by means of a stud on top and a roller underneath respectively. Fig. 3, drives lever *b* clear of the pawl and the ratchet clear of the trip pawl on lever *e*, and also moves lever *c* sideways.

Movement of lever *c* exerts pull on the flexible wire cable which is fixed to the back of the suspension arm, Fig. 5. This pull raises the needle clear of the record and holds it up. The second function of lever *b* is performed by an extended leg which now contacts a peg on lever *e*, Fig. 3 *Y*, and through it turns the raised arm clear of the record and keeps it in this position until the reverse movements start. Slightly before the slide reaches the end of its travel it performs still another duty; two faces on it contact levers *n*, Fig. 5 and raise the elevators to a position clear of the magazine. At this point the bayonet slot in the saddle contacts the stud in magazine lever *m*, Fig. 3 and, as the slide continues traveling, the magazine is revolved to a position directly over the turntable spindle. At the completion of the back movement of the slide, pins in the slide contact levers *l* turning them around their respective centers and revolving the elevators outwardly clear of the record, Fig. 3 *Y*, allowing the record to drop into the magazine. At this position, the mechanism is half through its cycle.

Prepares for Next Record

As the slide returns, the magazine is revolved back to its original position, levers *n* and the elevators descend, by gravity, and the spring on lever *b* returns it to its position of rest. As lever *b* returns, lever *d*, which was turned by the force of lever *b* against the stud in lever *e*, also returns by spring pressure, and it brings the suspension arm to the correct landing position, operating through lever *e*, where lever *d* contacts an adjustable stop. Lever *f*, Fig. 3 *Z*, positively secures the arm against any further movement by retaining the stud in lever *e* between its face and the phosphor bronze feed-in spring on lever *d*.

The roller on saddle *a* reaches the cam face on lever *c* as the slide continues forward, permitting this lever to move in a clockwise direction, thereby releasing the cable tension which permits the suspension arm to descend to the record and the cable to have sufficient slack essential for free arm operation. The elevators are again brought under the record, lever *b* is brought to a stop position in front of pawl *h*, and the tooth in the pawl is thrown clear from the driving ratchet by action of lever *c* and cam *k*, and motion of the record changing mechanism is stopped. As the roller on lever *c* rolls into the cam face on cam *k* just before the cycle is completed, the lever contacts a stud in lever *f*, releasing the stud in lever *e*, which permits the spring on lever *e* to feed the needle into the first record music groove, Fig. 3 *X* and *Z*.

The drive for the mechanism is taken from a motor of the constant speed capacitor type which has a stall torque of approximately 90 inch ounces. On one end of the armature spindle, a worm is cut which meshes with a helical gear that is fixed to the turntable spindle. The motor unit is mounted on its base by means of two adjustable torsional springs which eliminate motor hum vibration from the bottom plate. The gear train, which has a ratio of 28:1, consists of one spur pinion and gear and one helical pinion and gear. Gear centers are 0.006 over theoretical gear centers to compensate for possible manufacturing discrepancies.

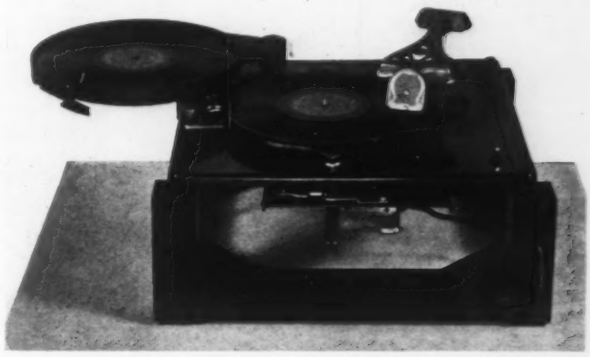

Fig. 4—Suspension arm is raised by pull of wire cable at the rear. Records are carried up by elevating levers

Protection of the record changing mechanism is afforded by a safety feature in the form of a slipping clutch. Predetermined spring pressure between cam *i* and pawl *h* is such that the motor driven ratchet on the turntable spindle, when in mesh with the tooth on the pawl, will be able to cam the tooth on the pawl out of mesh should any member of the mechanism be held against its driving force. This causes the driving of the mechanism to cease, but has no effect on the motor or the cycle.

For the reproduction of home recordings, personal favorites, 12-inch records, etc., a manual setting has been developed which eliminates the automatic features and produces a straight phonograph arrangement. Lever *o*, Fig. 3 *X* and Y, is the manual index lever. When turned to the stop in the motor board, it renders the mechanism inoperable, thus; a stud revolves lever *d* to an outward position, permitting a complete range of tone arm position, while another stud cams under lever *b*, insuring contact with pawl *h*, and a cam face on lever *o* shrouds the ratchet on lever *b* eliminating mesh with the trip pawl on lever *e* in any suspension arm position.

In addition to the requirement that a forced

stop of the mechanism should not affect the motor or the cycle, there was imposed the converse specification that should the starting switch be moved to the "off" position, the mechanism should conclude its cycle. This was satisfied by a secondary electric switch, Fig. 3 *X*, which closes by spring pressure the instant the slide saddle begins to recede, at the start of the cycle, thus making it impossible to stop the mechanism by shutting off the main starting switch until the cycle ends.

Smooth and positive operation of the suspension arm in its raising and lowering movements is accomplished by keeping the direction of cable pull directly in line with the vertical axis of the arm. Lever *g*, upon which the cable rollers revolve, also is contacted by means of a stud in lever *e* which swivels in accordance with the suspension arm position so that the line of action of the force is kept in the same relative plane regardless of the position of the arm.

After experimental models were made, it was necessary to add check lever *p* to the mechanism, as the load on the elevated suspension arm and

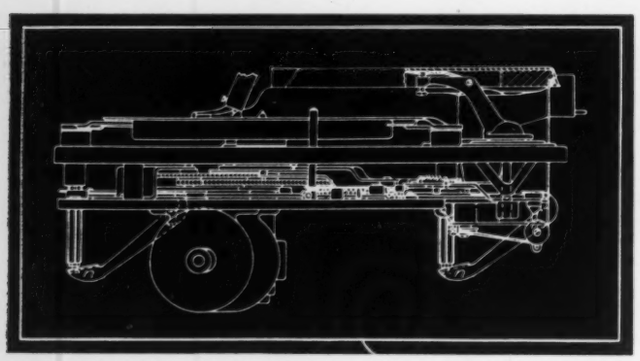

Fig. 5—Side elevation of record changing mechanism while it is in playing position

spring on lever *c* forced the slide ahead of the driving cam *k* when the cam face on lever *c* contacted the roller on the bottom of the saddle. The check lever also smoothed the power curve to better proportions by eliminating the hump at the start of the cycle.

As it was especially necessary that levers *m* and *e*, fixed to the magazine and suspension arm shafts respectively, Fig. 3 *X*, be in perfect adjustment and rigid, they are secured by means of one pointed screw and one blunt screw. The blunt screw tightens first, and, after proper location has been ascertained, the pointed screw seals the adjustment. The few essential adjustments are easily accessible, and the mechanism was designed with the thought in mind that adjustment be made before assembly on the motor board.

After the first design of the device had been completed, it was decided to add a long playing record mechanism, necessary for use of the new long playing records, and so provide two turntable speeds, namely 78 and 33 1/3 revolutions per minute. The change in speed could not be allowed to change the turntable spindle speed as this would change the cycle time automatically. With the addition of the long playing arrangement, it is possible to hear a program for two hours without any effort required by the operator.

This feature was procured by the addition of a unique planetary gear arrangement, Fig. 1 *B*, a section of the turntable spindle assembly. On the driving ratchet hub, a helical gear is pinned for driving the long playing two-speed device which has a pair of helical planets assembled on the turntable spindle as a unit and a suitable gear ratio necessary for the change in speed. A ratchet, *r*, not unlike the mechanism driving ratchet, is pinned on the inner gear driven bushing and the plate in which the planet bearing stud is spun has a cam, *s*, on its periphery, Fig. 1 *A*, and a pawl, *t* assembled on the top. When a turntable speed of 33 1/3 revolutions per minute is required, the turntable is driven by a tooth protruding from the top of the ratchet. When 78 R. P. M. is desired at the turntable, the shift lever is placed at the 78 position, permitting the pawl to drop into the mechanism ratchet thus rendering the planetary gears inoperable, whereupon the entire unit revolves at the speed selected. For true regulation at 33 1/3 R. P. M., it was necessary that the gear centers be placed 0.008 beyond theoretical centers. Two felt friction pads backed by phosphor bronze springs filter the backlash and keep the driven gear in contact with the driver by eliminating gear float.

Protective Measures Taken

The turntable is made heavier than is necessary to gain added inertia, therefore the driving device is such that should the turntable be revolving at 78 R. P. M. and the mechanism be shifted for 33 1/3, the turntable will float ahead without shocking the driving gear in the motor due to the sudden change in speed and load and wait until it is driven again by the protruding ratchet tooth.

Dimensions and details for parts on a device of this nature should be proved by building a model from manufacturing drawings before tool drawings are started. Should the model assemble and perform perfectly, possible drafting room errors may be eliminated. If the first device assembled from production parts after the model has operated correctly does not assemble and perform properly, it is evident that the discrepancy lies in the tools. This procedure gives the shop man something definite to work on should he run into minor troubles at the start. The processing for a mechanism of this type is important and much time and trouble may be saved when parts are analyzed and the sequence of manufacturing operation along with locating points are ascertained before designing tools.

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

Motion Picture Field Broadens

COMMERCIAL motion pictures in relief soon may be a reality and through their development a wide field will be opened for designers of projection equipment. The idea of relief motion pictures is being carried through the experimental stage by Dr. Herbert E. Ives of Bell Telephone Laboratories, New York.

Dr. Ives' present three-dimensional work does not employ the conventional celluloid film but reverts back to a toy that the older generation will remember in which a series of pictures is mounted on a revolving wheel. Although the action prevails only a couple of seconds before it repeats, the spectator sees a true motion picture which has all the depth and roundness of a stereoscopic view.

The cumbersome wheel, Fig. 1 (inset) thus far is essential because of the high degree of accuracy of position needed to project the pictures on a special screen, Fig. 1, which is one of the basic elements of the system. The screen is made up of vertical celluloid rods ground to an accurate cylindrical curvature at front and rear. By throwing successive elements of the picture in the form of vertical lines on the back of successive rods, the whole picture is built up for the observer. The picture on each successive element of a rod is refracted in a slightly different direction, so that the two eyes of each observer will see different pictures, the principle being similar to that employed in the familiar stereoscope.

To produce a series of slides that would present satisfactory motion pictures when viewed by an audience from various angles, Dr. Ives employed a concave mirror, inasmuch as it was desirable to make the pictures with apparatus employing a single photographic exposure. Light rays from the object placed at the focus of the mirror are prevented from reflecting back to a focus at their origin by a semitransparent mirror which reflects them off at right angles. At the new focus of the mirror thus established, a group of images of the object are formed, one for every possible viewpoint around the concave mirror.

Discrimination between images is effected by interposing a glass screen of fine concave grooves. This breaks up each image into a series of lines spaced regularly across a photographic plate. In the space between adjacent strips of one view appears, in order, a strip from each other view, so that if one eye of the observer could see but one set of strips, it would perceive the picture as viewed from one point on the concave mirror as though seen through a grille of thin vertical wires. Precisely this effect is ob-

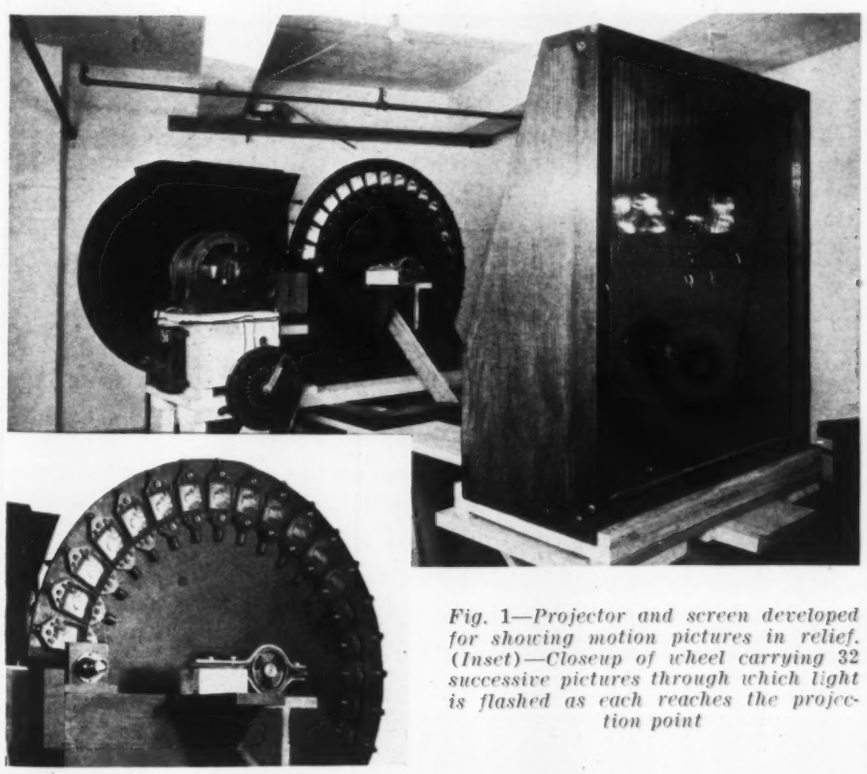

Fig. 1—Projector and screen developed for showing motion pictures in relief. (Inset)—Closeup of wheel carrying 32 successive pictures through which light is flashed as each reaches the projection point

tained by making a lantern slide from each plate and projecting it upon the back of the glass screen shown in Fig. 1. Each eye of the ultimate observer thus sees a different picture and stereoscopic vision is obtained.

Design Materials Find Acceptance

ODORLESS, vermin-proof, nonhygroscopic, fireproof, vibration resistant and, chief of all, exceptionally light (a cubic foot weighs only three ounces), are some of the characteristics of a new aluminum foil recently introduced into this country by Alfol Insulation Co., Chrysler building, New York, in conjunction with Aluminum Co. of America. As a basis for insulation,

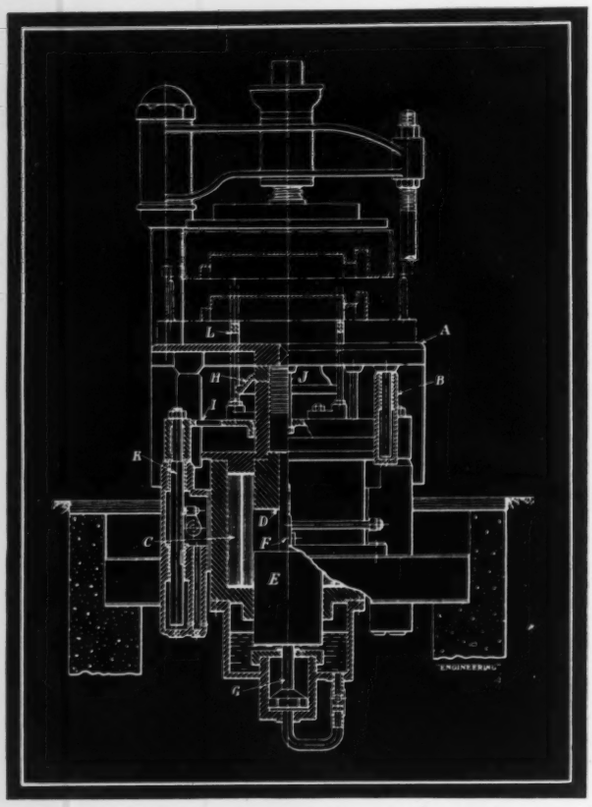

Fig. 2—A solenoid instead of hydraulic or pneumatic mechanism is employed to operate this molding machine

designers may find in this new material a suitable medium for domestic as well as industrial applications.

The insulation is built up by applying successive layers of foil around the unit to be insulated at intervals of approximately 1/3 inch. About 0.0003-inch thick, the foil is crumpled so as to produce irregular ridges and valleys throughout the sheet. The product is claimed to afford insulation protection up to 1150 degrees Fahr., melting at 1200 degrees.

Another material which is attracting the attention of engineers is one which exhibits practically all the characteristics of rubber but is unaffected by solvents, this being an olefin-polysulphide reaction product known as Thiokol. Because of the material's unusual resistance to the deteriorating action of most gases and liquids, particularly gasoline and oils, it is being used extensively in the automotive industry.

Among many other applications which either have been made or for which tests are being conducted are: Covering for ignition wire for protection against oil and corona conditions, paint spray hose, gaskets for electrical refrigerators to protect against refrigerant gases, tank car linings for conveying acids and solvents, protective covering for underground cables, gaskets and gas tanks.

The new product is being produced commercially by the Thiokol Corp., Yardville, N. J. It is made entirely of chemicals, containing no rubber whatsoever, yet like rubber it is compounded and vulcanized in processing finished articles. In appearance it is similar to crude rubber.

Solenoid Simplifies Foundry Unit

SOLENOIDS often may be employed to advantage in machines which lend themselves to a simple electrical arrangement embodying a self-contained unit for providing power. This is particularly well illustrated by a magnetically-operated molding machine recently developed by British Insulated Cables Ltd., Prescot, England. In this new development the need for the conventional electric motor, air or hydraulic pipe lines, compressors or accumulators was eliminated.

As described in a recent issue of *Engineering* and depicted in Fig. 2, the foundry unit is the squeeze strip type, actual squeeze being effected by the action of a solenoid. One to two seconds is required for the squeeze, and the pattern is drawn by gravity on the down stroke.

Pattern table shown at *A* is slotted for the attachment of the pattern plate, rods *B* at each of the four corners acting as guides. Solenoid *C* is made of one or more sections, according to the length of movement required, and when energized acts upon both the stationary core *D* and moving core *E*, both constructed of mild steel.

Moving core *E* is attached to rod *F*, of nonmagnetic material, which carries the table. Connection with a piston working in dashpot *G*, controls the speed at which the table moves, the length of stroke depending upon the distance between the stationary and moving cores. The moving core and the table can be raised relatively to the stationary core by handwheel *H*.

Adhesion Drive Solves Problem

PROPOSED plans for a practical system of continuous high-speed transportation incorporate a radical change in the mechanical details of the rolling stock. The biway system,

as it is called, would replace individual trains making bursts of speed between stations, with two continuous trains or belts of cars running on parallel tracks with stationary landing platforms along the entire route. Fundamentally the biway is a development of the moving sidewalk idea, and embodies a synchronization of movement which might be employed to advantage in large conveyors or small conveyors within machines.

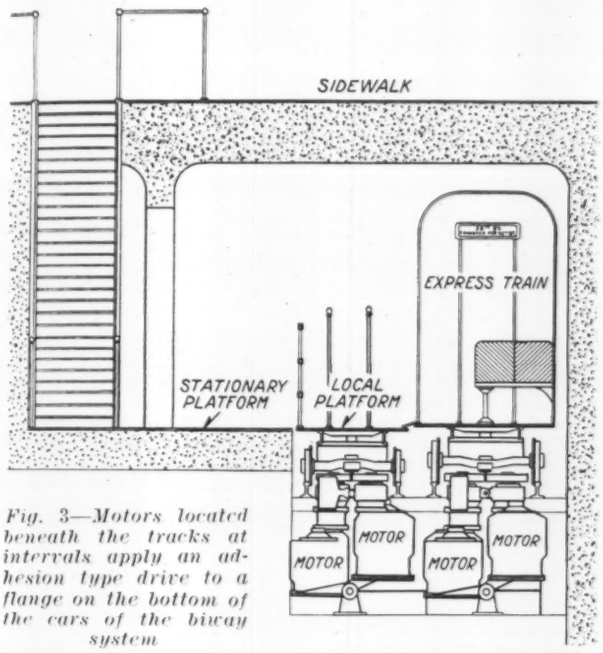

Fig. 3—Motors located beneath the tracks at intervals apply an adhesion type drive to a flange on the bottom of the cars of the biway system

Although no such systems have yet been built, N. W. Storer, consulting transportation engineer of Westinghouse, who has spent several years evolving the idea, explains some of the essential features. Passengers board the first of the moving platforms or belts of cars at any loading point. When its speed reaches that of the second parallel platform, gates open and passengers enter the express train where they remain until near the end of their trip. They then transfer again to the local, or stopping, platform. Between its meetings with the local platform, the speed of the express increases to 22 miles per hour, slowing down to 17 when the two are running level.

Driving motors are stationary beneath the tracks at intervals of about 1000 feet, this greatly reducing operating noise. Fastened lengthwise beneath each train is a T-section, the flange of which runs between driving wheels of the motors, Fig. 3. The drive is of the adhesion type. Wheels of the trains have no part in the driving, merely serving to carry the trains on conventional tracks.

Engineering features prevent the loss of power; as the local slows down for a stop it gives up power to the express which is increasing its speed at that portion of the cycle. When the local is picking up speed to match that of the express, the latter is slowing down and gives power it no longer needs back to the accelerating local. This type of system is viewed as the solution to a major problem in the transportation of masses of people.

Powders Modify Testing Method

DISTINCT advantage lies in employing nondestructive tests inasmuch as the engineer thus may ascertain the limitations of a product without damage. These test methods may be classified as magnetic, radiographic and sonic, their application depending largely upon the detection of some heterogeneity in the field of flux —whether that flux be electric, magnetic, actinic or sonic and whether the field be that of the passage of an electric current, magnetic field, a penetrating light ray or a sound wave.

In discussing methods of testing in a paper before the recent meeting of the Iron and Steel institute, Robert F. Mehl, assistant director, research laboratories, American Rolling Mill Co., outlined the application of iron powders to the detection of surface defects. This is a modification of the magnetic leakage method and has been used rather extensively in the commercial inspection of gas cylinders, valve springs, heavy-duty bus springs and airplane propeller parts.

Recently deForest developed an improved form of dry powder known as "Magnaflux powder," to give maximum response toward flux leakage. Its use to show seams in a screw is illustrated in Fig. 4. The same piece polished but not under test also is depicted. This comparison brings out the advantage of using this method to detect defects, the presence of which even polishing may not disclose.

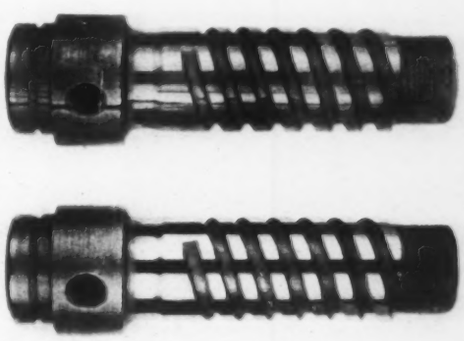

Fig. 4—Cracks in screw disclosed by magnaflux powder are shown at top. Polishing did not show defects (bottom view)

Magnetization may be applied in numerous ways. If the steel is magnetically hard it may be magnetized initially either by means of an electromagnet or by passing current to induce circular or nonpolar magentism; if magnetically soft it must be tested while the magnetizing force is applied.

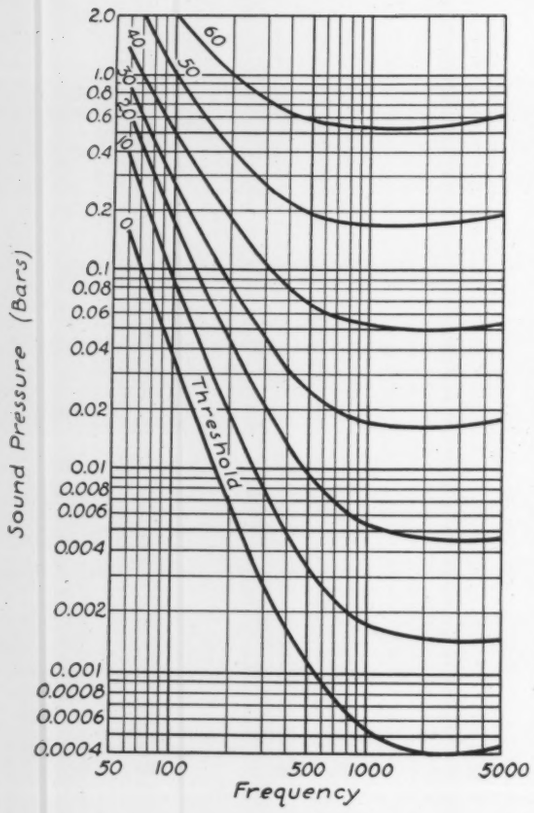

Fig. 1—Equal loudness contours, measured in bars, as they vary with the frequency

Effective Noise R on Basic K

By P. H. Geiger

IN many branches of industry the economic value of noise reduction is being appreciated more and more each year, for a number of manufacturers have found not only that the efficiency of their employes has been increased by a reduction in the noise of their offices and factories, but also that the adoption of means of quieting their product has lightened the work of their salesmen. An increasing number of purchasers compare the quietness of various competing machines before they make their decision as to which to buy. This of course holds true especially for purchasers of equipment for use in homes, but it also applies to some extent to equipment used in manufacturing.

It has been found that noise often produces undesirable, and even harmful, physiological and psychological reactions. Even when an individual has become so accustomed to a noise that he is not conscious of its existence, undesirable effects still are produced. It is sometimes said that noise in a machine indicates inefficiency. This in general is not true, for an extremely loud noise represents only a minute amount of power. It has been estimated that ten million cornets being blown fortissimo would radiate in sound only one horsepower. From a design viewpoint then, a reduction in noise cannot be expected to increase appreciably the power efficiency of a machine.

Usually the problem of designing a machine to obtain a minimum noise is an individual problem for each type of machine. However, there are a few principles which will be of aid and which, when properly applied, may prevent some of the common mistakes. In general, the noise of a machine may be reduced by making use of one or more of the following methods: Reduction in the amount of sound radiated by preventing the transmission of vibrations to good sound radiating surfaces; elimination of possibilities of resonance, either mechanical or acoustic, between any of the noise components and a part of the machine; construction of the rotating parts in a manner such that the frequencies of the main noise components will lie in a region of comparative insensitivity of the ear; introduction of sound absorbing material; and establishment of close tolerances for moving parts thereby reducing play. Before showing how these general methods of noise control can be applied to the design of machinery, the method of designating noise will be described together with the characteristics of the ear which should be known to anyone who undertakes a problem of noise reduction.

Before the loudness of a noise can be measured, or even described, a unit of loudness must be established. The characteristics of the aver-

COMPLETE elimination of the most troublesome noise component may not have an appreciable effect on noise in a machine because of the basic characteristics of sound. Dr. Geiger, department of engineering research, University of Michigan, explains these characteristics. In the next article in this series, begun in the June issue of MACHINE DESIGN, employment of these factors in noise elimination will be described.

Reduction Depends Knowledge

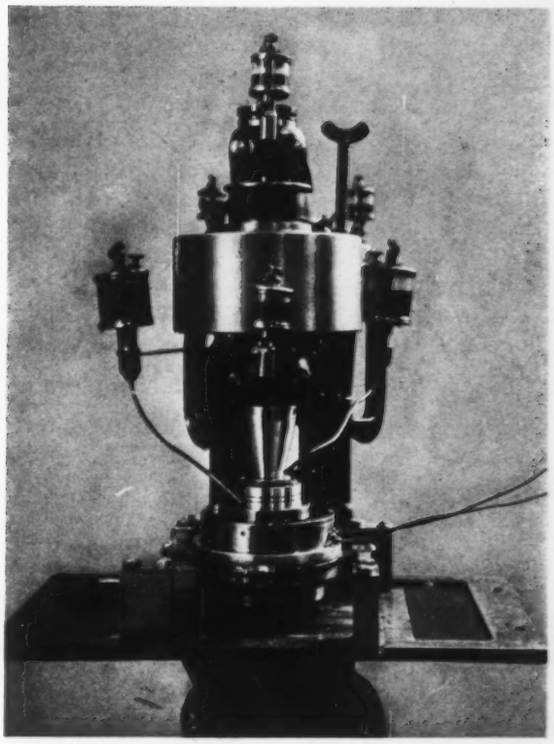

Fig. 3—Roller bearing noise test machine determines actual disturbance created

age ear must be considered in making the definition, for the perception of sound is a psychological process rather than a physical process.

Since a musical tone is less complex than a noise, the method of designating it will be examined first. The pitch of a tone may be specified by the frequency of vibration. Since airborne sound is essentially a fluctuation of atmospheric pressure, the magnitude of a tone may be specified by this fluctuation. A fluctuation in atmospheric pressure having a frequency of say 1000 cycles per second corresponds to a reasonably loud sound even if the fluctuation is only a millionth of atmospheric pressure. A pure musical tone, that is, one without harmonics (overtones), is specified completely if its frequency and its acoustic pressure are given.

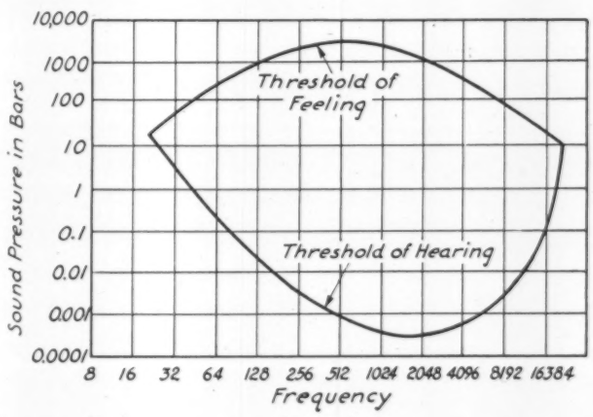

Fig. 2—The sensitivity of the average ear ranges between sounds than cannot be heard and those that can be felt

The technical description of a noise is not as easy as is the description of a musical tone. Often no definite pitch can be assigned. In general, a noise consists of a number of musical tones together with irregular sound impulses which may be termed "unpitched noise". By measuring the frequency and acoustic pressure of each of the musical tones and the acoustic pressure of the unpitched noise, a means of describing the noise is secured. However, since it often is desired to express the loudness of a noise by a single number, a means of doing this has been devised.

The ear responds to a limited range of frequency and its sensitivity varies greatly over this range. The lower curve of Fig. 2 shows the sound pressure of the minimum audible tone, as a function of frequency.[1] The upper curve gives the threshold of feeling. Sounds having pressures corresponding to points below the lower curve cannot be heard by the average ear. Sounds having pressures corresponding to values above the upper curve stimulate the sense of feeling and are painful to the ear. The unit of pressure used for plotting the curve is the bar which is equal to one dyne per square centimeter or 0.0000145 pounds per square inch. Atmospheric pressure is about 1,000,000 bars.

The chart represents average results obtained from tests on a large number of observers. Curves for individuals are frequently quite different from the average.

From the above discussion it is evident that the amplitude of a sound expressed in units of pressure does not represent adequately the loudness of sound. For example, a sound of frequency 1000 cycles per second having an acoustic pressure of 0.2 bar will be comparatively loud, whereas a sound having the same pressure but of a frequency of 50 cycles per second cannot be heard. If the sound pressures of two sounds, which are of equal loudness to the ear but which are of different frequencies, are in-

[1]Data for the curves of Fig. 2 were taken from information published by Bell Telephone Laboratories.

creased or decreased an equal amount, they then will not be equally loud. From these considerations it is evident that the relation between sound pressure and loudness is not simple.

In order to have a scale which will assign the same values of loudness to all tones which appear to be of equal loudness to the ear, it is necessary to establish a suitable loudness scale for a single frequency and to provide that all tones which appear equally loud to the average ear are assigned the same loudness value. A tone of frequency 1000 cycles per second usually is chosen as the reference tone. The loudness scale gives the relation between loudness and sound pressure by the following equation:

$$\text{Loudness} = 20 \log_{10} \frac{P}{P_0} \quad \ldots\ldots (1)$$

where P is the acoustic pressure of a 1000 cycle per second tone of loudness equal to the sound being specified and P_0 is the acoustic pressure of the 1000 cycle tone which barely is perceptible to the average ear. The unit of loudness defined by this equation is called a decibel[2]. One decibel corresponds roughly to the minimum loudness change which the ear can detect under the best conditions.

Reference Tone Pressure Needed

In order to designate the loudness of a tone of known pressure and of some frequency other than that of the reference tone, it is necessary to know the pressure of the reference tone which appears equally as loud to the ear. This pressure can be determined by the use of the curve shown in Fig. 1. Data for these curves were obtained in the Bell Telephone Laboratories[3]. The curves give the acoustic pressures of tones of different frequencies which have loudnesses of 10, 20, 30, etc. decibels on the loudness scale under discussion. As will be shown, these curves may be useful in designing machines, for by their use it may be possible to determine which of several types of construction will be the most quiet.

In order to designate the loudness of a noise it also is necessary to know the pressure of the equally loud reference tone. To determine this value experimentally, sound measuring equipment usually is necessary, Figs. 3, 4 and 5.

Although loudness measurements are of great value in comparing the noises made by different modifications of a given machine, they do not give all the information which may be desired. For example, they cannot give the relative importance of the various components of a noise. A great deal of effort often is wasted by reducing or eliminating components of the noise which are of minor importance. Due to the logarithmic response of the ear and due to the peculiar way

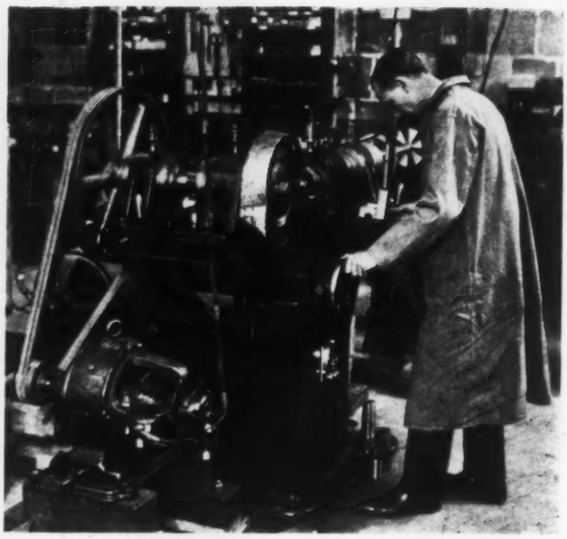

Fig. 4—Vibration measurements of spiral bevel gears are made on a matching machine. The gear set is loaded by the electric generator in left foreground

in which the ear adds the different components of sounds, it is usually of little benefit to reduce any of the noise components other than the loudest. For example, if we have a machine with a loudness of 60 decibels and find by measurement that the noise made by the ball bearings operating alone has a loudness of 50 decibels, one is apt to assume that considerable noise reduction could be secured if the bearing noises were eliminated. Such is not the case however, for even if noiseless bearings could be found, the loudness of the machine would be reduced

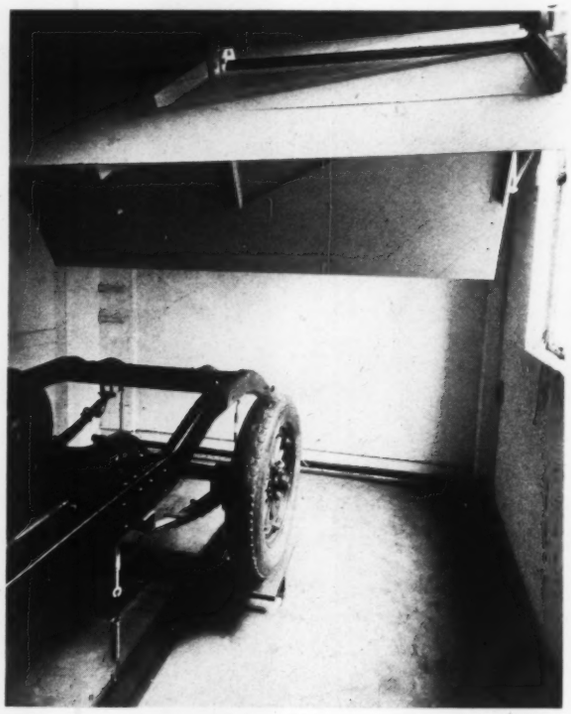

Fig. 5—A small sound chamber. The four-bladed reflector shown at the top is revolved so that the intensity of sound integrated over a short time is substantially the same at each point in the room

[2]The chart shown on page 13 of the June issue of MACHINE DESIGN will aid in giving a concrete idea of the loudness scale.

[3]Kingsbury, "The Loudness of Pure Tones," *Physical Review*, Vol. 29, p. 588, April, 1927.

only from 60 decibels to about 59.5 decibels.

In a few cases the elimination of a single noise component may be extremely desirable even though the total loudness of the machine may not be altered perceptibly thereby. This will be the case when the component possesses a particularly annoying characteristic. Any noise, if loud, is of course annoying, but two noises which are equally loud are not necessarily equally disagreeable. The annoyance feature of a noise is, to a great degree, determined by the mental associations connected with it. For example, a noise which sounds like the noise of a bearing badly in need of lubrication will be

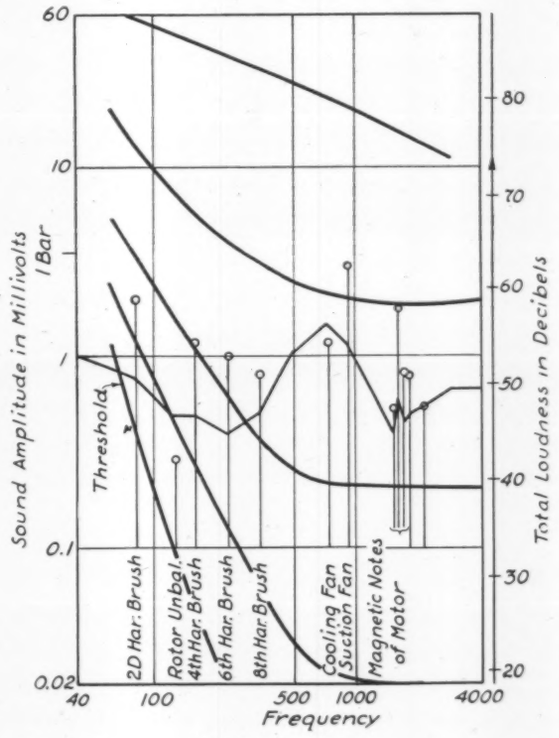

Fig. 6—Noise analysis of a vacuum cleaner indicates the troublesome parts

disagreeable to a man accustomed to working with machinery.

Since it is desirable that efforts to reduce the noise of a machine be confined to those parts of the machine which produce the loudest or the most disagreeable noise components, the analysis of noise is of great advantage. A sample noise analysis is shown in Fig. 6; this chart gives the results of measurements on the noise of a vacuum cleaner and will serve to show what information an analysis may give. Each of the vertical lines topped with a small circle represent a musical tone present in the noise. The frequency of the tone is given by the position of the line along the frequency axis. The height of the line gives the acoustic pressure produced by the tone. Equal loudness contours are plotted on the chart; the position of the small circles with respect to these contours gives the loudness of each component. Total loudness of the machine is indicated by an arrow on the scale at the right.

The cause of each component is indicated on the lower portion of the chart. The machine tested was equipped with a rotating brush running at a speed of about 40 revolutions per second. If one sound impulse was sent out on each revolution, the frequency of the fundamental of the resulting tone would of course be 40 cycles per second. A tone of this frequency was not found, but tones having frequencies corresponding to the second, fourth, sixth, and eighth harmonics were found. Since only the even harmonics are present it probably is safe to conclude that the action which produced sound occurred twice each revolution. The tone of frequency about 140 cycles per second shows that, although the rotor was slightly out of balance, a better balance would not decrease the machine noise perceptibly. The cleaner used for this test was equipped with a fan for cooling the motor as well as the main suction fan. Fan tones due to each of these fans are prominent, although the suction fan gave a much louder tone.

Magnetic Tones Important

Three tones shown on the chart are labeled as being magnetic tones. Each time an armature slot passes a field pole tip the magnetization of the tip changes. These periodic changes in magnetization produce sound because of the resulting variation of the force on the laminations and because of the actual change in dimensions of the iron due to the magneto-striction effect. The frequency of the middle of the three magnetic tones is equal to the product of the number of armature slots times the speed expressed in revolutions per second. The cause of the two outer tones is quite interesting: When the measurements were taken the machine was operated on 60 cycle alternating current, so the current through the motor windings passed through zero 120 times per second; this modulated the true magnetic tone thereby giving rise to the two side band frequencies, one 120 cycles below the magnetic tone frequency, the other above.

An examination of the chart shows that the suction fan tone and the magnetic tone are the two loudest components in the noise of the machine. Reducing or eliminating any of the tones other than these two, will have little effect on reducing the machine noise, unless these two first are reduced greatly.

Keeping in mind the characteristics of the ear and the relation between pressure measurements and loudness as outlined in the foregoing, consideration will be given in the August issue of MACHINE DESIGN to the general methods of noise reduction.

Developing the Overrunning Clutch

By Austin M. Wolf

INTRODUCTION of free wheeling in automobiles has been accompanied with so much spontaneous publicity that few realize the steps required to bring the overrunning clutch to its present perfection. Mr. Wolf, consulting engineer, New York, shows how the design has progressed in this abstract of a paper presented before Society of Automotive Engineers. Much of the data can be applied to clutches for industrial use.

WITH free wheeling in use on about two-thirds of the present American production chassis models, there can be no doubt that the system has merit and has been accepted by the buying public as an improvement over the conventional drive. Manufacturers of the remaining models must believe that the device has disadvantages that outweight its advantages, but it is evident that at the moment this opinion is not held by the majority.

The use of overrunning-clutch devices dates back to almost the beginning of the design of machinery. Concerning vehicles, we might divide the various possible means into electrical, fluid and mechanical. The electrical method appears in most gasoline-electric drives, while the fluid type has appeared in hydraulic drives. The late C. M. Manly, once president of the Society of Automotive Engineers, built a hydraulic drive with a bypass between the delivery and the return lines. A check valve therein would correspond to a free wheeling device.

While little work has been done on the use of compressed air as a medium between a compressor and an air motor, the bypassing effect can be incorporated in such a system. The atmosphere would serve as an infinitely large reservoir, obviating the need of a closed circuit. We are interested, however, only in the mechanical devices which are based on the ratchet principle. Present practice includes two types, the roller ratchet and the spring clutch drive. The ratchet design is of interest in view of present experience as to the rigorous ordeal to which such members are subject.

The load carried by each roller in a roller ratchet is a function of its displacement and, since smaller rollers such as those in the early Studebaker multiroller design, Fig. 2*A*, move most, they take most of the load. We are dealing with elastic bodies in spite of the sectional thickness of the shell and the cam. In the Studebaker laboratory, measurements were made of the distortion in the shell with the cam held stationary and a torque load placed on the shell. The second smallest roller showed the greatest displacement. Sometimes the shell showed a permanent set over the smallest roller. Roller diameters were varied experimentally to redistribute the load, especially to throw more load on the largest roller; but this was found to be impracticable for production, so resort was had to the single roller design.

Lugs Are Integral

The present Studebaker cam, shown in Fig. 2*B*, has its cam surfaces in the form of arcs tangent to the base circle, and the lugs which house the springs and guide the shell are integral, both as in the original cam. With a roller diameter of 0.333 inch and a shell diameter of 3.5625 inches, the angle between common tangents of the roller and the cam and of the roller and the shell at the time of initial engagement is 2 degrees 30 minutes. The normal driving angle varies with the load; at maximum low gear torque, the cam angle in the President transmission is approximately 5 degrees 50 minutes to 6 degrees. The engine develops a maximum torque of 240 pounds feet, and the transmission low gear ratio is 2.83:1. The unit contains eight rollers.

Early workers on roller clutches assumed that the state of the art in producing rollers for antifriction bearings had progressed well nigh to perfection. In the free-wheeling unit conditions are entirely different, especially when consideration is given to possible spinning speed.

Taking figures derived for shell and roller diameters, the theoretical maximum speed of a roller with the engine stalled and the car free-wheeling at 60 miles per hour is approximately 31,000 revolutions per minute. Exceptional treatment is required to produce a roller that will stand up in this service.

H. T. Woolson, Chrysler Corp., has determined that, "To have the free-wheeling unit of the three-lobe cam design, having three rollers per cam, work only in one direction, the rear side of the roller retainer is provided with four lugs which extend into cam slots. As soon as the cam slows down in respect to the driven shell, the roller retainer as a unit is moved back on the cam until the lug strikes the side of the cam slot and stops the backward movement of the rolls in respect to the cam, thus preventing reverse locking of the free-wheeling unit. Each cam lobe has a relief to give the roll sufficient clearance in free-wheeling position; otherwise the rolls would spin and the free-wheeling unit would be noisy.

Rollers Can Be Made Larger

"Our small cams have as many as 13 rolls up to 1-inch long. The rolls could be made longer if desired, and as small as ¼-inch diameter. It is obvious, assuming that all rolls do their work as they do in the retainer type, that the more and the longer the rolls are, the lower are the unit pressures and the smaller can be the sizes of the other parts."

Another type of free-wheeling unit, the old Mercedes band-type clutch, in which the band contracted on a flywheel drum, will be recalled by many. Its method of operation is described in textbooks as belt or coil friction. The same principle is applicable equally to a contracting or wrapping coil or an expanding one. This construction is utilized by the L. G. S. Devices Corp. for a free-wheeling device. Fig. 1 shows the three essential parts that make up a device of this type as used by Chevrolet.

To prevent indentation of the rollers or wear in the cam in the ratchet type, the Warner Gear Co. makes both the cam member and the shell

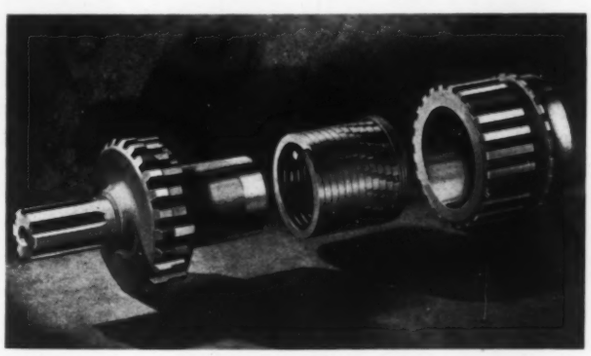

Fig. 1—Major parts of an overrunning clutch which employs an expanding or contracting coil

of S. A. E. 4615, with careful attention to heat-treatment. They provide a hard case with a dense body immediately below it. A minimum hardness of C61 Rockwell is required on these surfaces. The rollers are kept slightly softer, to prevent crushing or flaking, the range being C56 to C60 Rockwell. According to investiga-

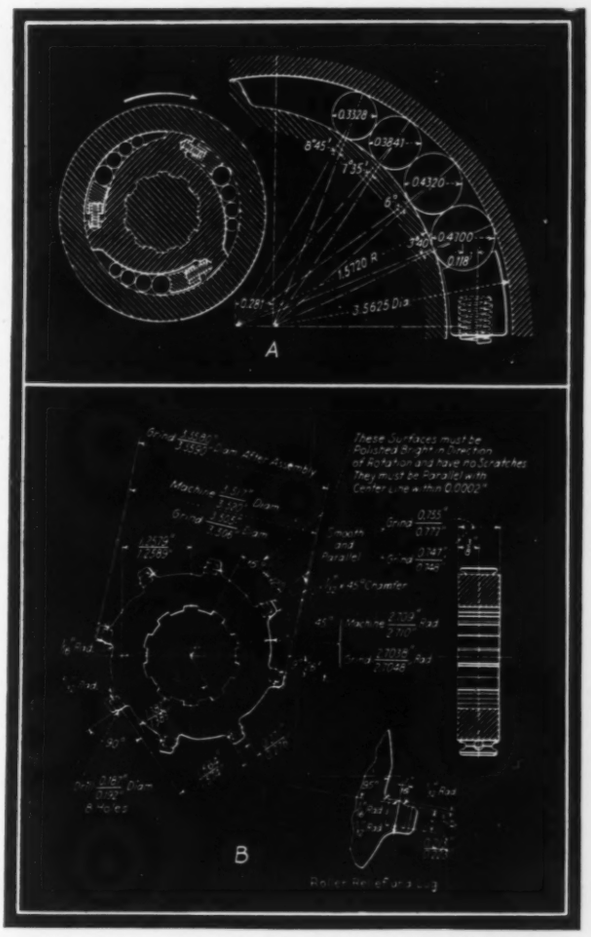

Fig. 2—A—Layout of cam and rollers of early multiple roller design. B—Cam of present Studebaker unit of single roller design

tions carried out by Bantam Ball Bearing Co., best results are obtained by S. A. E.—52100 chromium steel coming from the mill in round bars, cut off to length and each end chamfered by a coining process before the first tempering. This is followed in order by centerless grinding of the diameter, end grinding, the second tempering, finish grinding and lapping carefully to remove the roughness produced in the centerless grinder. The rolls are held to a tolerance of ± 0.0001 inch.

Almost any lubricant within reason will do when a roller ratchet is new and engagement is perfect. When wear in the cam surface results from spinning, the local cam angle is altered. The viscosity effect of the lubricant tends to prevent the roller from passing, in engagement, beyond the depression thus formed. If the resistance is great enough to prevent the roller

(*Concluded on Page* 28)

Designing and Applying Photoelastic Equipment

By D. L. Pellett

COMPLETE knowledge concerning the distribution of stress in a machine part is necessary for efficient design. This knowledge cannot be obtained entirely by mathematical analysis because in any but the simplest of problems solution is laborious, incomplete, and results are made questionable by many assumptions. The designer of machinery has found a valuable ally in photoelasticity; a method of analysis which can be applied to the solution of any coplanar stress problem. Results are relatively accurate, obtained easily, and often reveal unexpected "sore spots" in the structure.

Many excellent papers on photoelastic investigation have been written during the past few years, yet the method has not achieved the universal use its merits deserve. This condition may be due to a lack of information concerning the apparatus and the technique of its operation, many engineers being under the false impression that the photoelastic polariscope is too elaborate and too expensive for use in the average engineering department. The writer has used a polariscope that is no more elaborate or expensive than a good projection lantern. Equipment designed for photoelastic research cannot be purchased from American scientific instrument companies at the present time, but the constituent parts can be purchased and assembled by the user to form a complete unit.

Photoelastic Method Discussed

Before describing the apparatus and some of the results obtained by its use, it seems advisable to include a discussion of the photoelastic method. More complete treatments of this subject can be found in the papers listed in the bibliography at the end of this article.

Transparent, isotropic materials such as glass, celluloid, and bakelite become double refracting while under stress. For any given material the amount of double refraction depends upon the difference between the principal stresses in the plane of the specimen, a difference equal to twice the maximum shear stress. If a stressed, isotropic sheet is placed across the polarized beam of a polariscope using white light the projected image will be covered with colored bands. The color of any given spot on the image is an index of the amount of double refraction produced by the specimen. Since color is an index of the amount of double refraction, and double refraction is an index of the maximum shear stress, then any given color corresponds to a known maximum shear stress. This facilitates the making of qualitative stress studies by means of a color scale. Stress values corresponding to given colors depend upon the light source and the thickness and nature of the material in the model. However, the sequence of colors is determinate. Black is produced by zero stress, changing to grey, white, yellow, red, violet and green with increasing stress, a sequence repeated with a further increase in stress. The duplication of colors in several different orders seldom causes any confusion.

The relative stress distribution in a strained elastic body is independent of physical coefficients. This fact permits the use of small scale models made of transparent elastic substances for studying the stress distribution and stress magnitudes in large structures built of opaque elastic materials.

With the exception of contact stresses, (as in

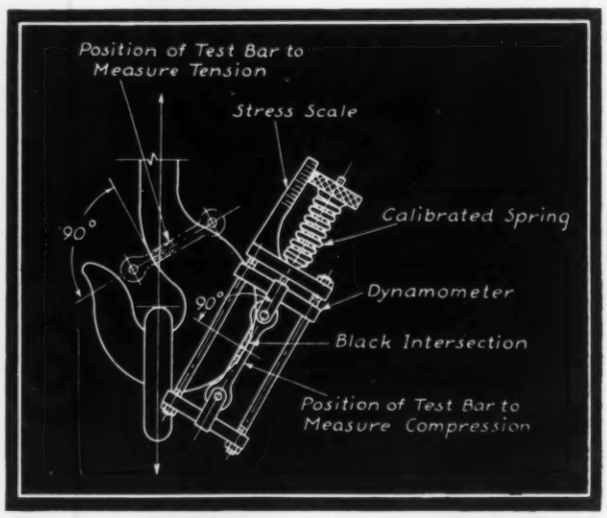

Fig. 1—Tension on test bars is increased until intersection of bar and model produces a narrow black band on the screen

cams, gear teeth, etc.) and torsional stresses, the stresses in machine parts are produced by axial loads, bending moments, or a combination of both. In these cases the critical stresses, which can be measured photoelastically by the following method of "compensation," will be found at the perimeter of the member. A tension test bar and the model are cut from the same sheet of material. This test bar is placed in the polariscope at such a position that the axis of the bar is normal to the perimeter of the member being tested, Fig. 1. The tension in the test bar then is increased until the intersection

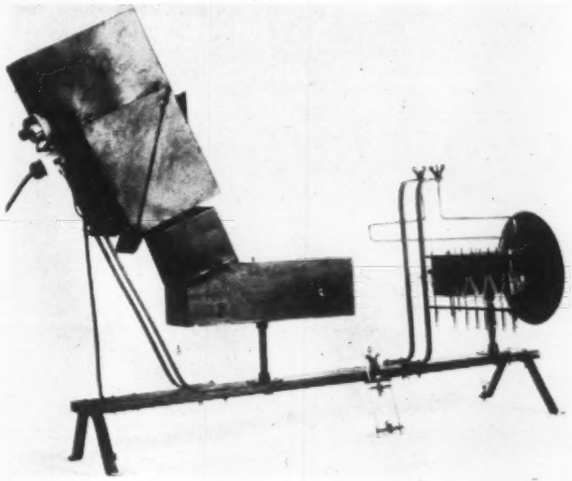

Fig. 2—Portable instrument for photoelastic investigation in which is mounted a model wing truss

of the bar and the model produces a narrow black band on the screen, this indicating that the tension in the test bar, which is known, is equal to the tension in the perimeter of the model at the given point. If the perimeter of the model is in compression, the tension test bar must be turned through 90 degrees to produce compensation. This change in orientation is a method for differentiating between tension and compression.

The essential parts of a photoelastic polariscope are: The light source, a polarizer, a pair of quarter wave plates, an analyzer, a lense system, and a screen, Fig. 3.

A monochromatic light source is an asset in photographing photoelastic results but it becomes a liability for visual analyses. White light sources produce images covered by contrasting bands of many colors, an effect lost with monochromatic light sources since the resulting bands will be varying shades of the same color. A 500-watt concentrated filament bulb is a very satisfactory light source for ordinary work. Since an approach to a point source is desirable, it is not advisable to use a reflector behind the bulb.

The polarizer is the most important element in a polariscope. Nicol prisms can be used for this purpose, but these prisms are exceedingly expensive, large ones are hard to obtain, and they must be protected from the infra red rays (heat rays) of the light source. Equivalent results can be obtained by means of a stack of glass plates. If light is reflected from a glass plate set at an angle of incidence of 57 degrees, 14.7 per cent of the incident light will be reflected. This reflected light will be plane polarized and will be vibrate in a plane normal to the plane of incidence. If this single plate is replaced by a stack of glass plates, a greater percentage of the light will be reflected and polarized, the increase in percentage following a law of diminishing returns based upon the number of plates. If twelve plates are used, the amount of incident light reflected and polarized approaches 50 per cent, the maximum possible.

Circular Polarized Light Used

Most photoelastic problems are solved with circular polarized light formed by the combination of two sinusoidal wave trains of the same amplitude and wave length. These rays must be vibrating in perpendicular planes and must have

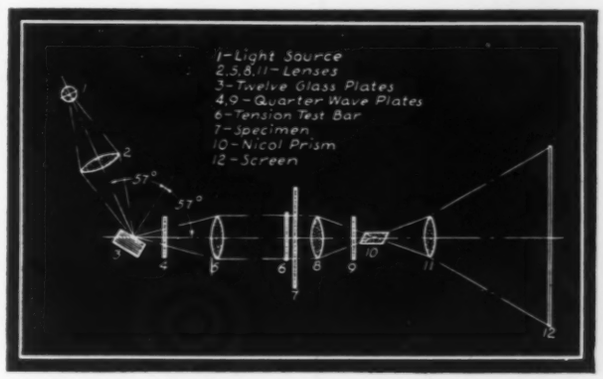

Fig. 3—Schematic diagram of a photoelastic polariscope that can be built readily by the user

a relative phase lag of one quarter of a wave length. Production of this effect can be effected by placing quarter wave plate, a thin sheet of mica of the correct thickness, across a beam of plane polarized light. The optic axis of the wave plate must make an angle of 45 degrees with the plane of vibration of the incident light. A second quarter wave plate cancels the effect of the first plate. The optic axes of the two plates must be mutually perpendicular.

The analyzer is a small Nicol prism set for extinction, that is, the Nicol is rotated until the projected image has a minimum of illumination.

No general rules can be given for the design of lense mountings and the optical bench as size of the models to be tested and the desired degree of compactness will influence the builder. Fig. 2 is a photograph of a portable instrument in which is mounted a model airplane wing rib

truss. A dynamometer frame with a tension test bar in place is seen in front of the instrument.

Results of photoelastic tests on a curved beam are shown in Fig. 4. The part in question is a model of the front lift beam used for hoisting locomotives, a problem representative of a class of curved beams often used by machine designers. While a mathematical solution of this problem is by no means impossible, such a solution would be laborious and incomplete. The greatest difficulty would be encountered in determining the stresses at the fillets.

The curves superimposed upon the beam outline represent stress values along the perimeter

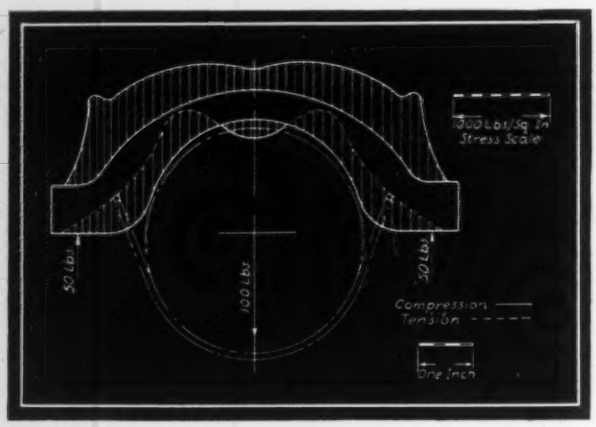

Fig. 4—Test results on a model of a curved front lift beam used for hoisting locomotives

of the model, while the length of the ordinate from the curve to the perimeter of the model is the tangential stress value at the corresponding point. These curves indicate that the fillets are highly stressed. An increase in the fillet radius would lower the stresses with a resultant increase in design efficiency. Additional improvements in the design will be apparent after a thorough study of the stress distribution in the beam.

Many additional examples could be given of photoelastic analyses but this does not seem necessary. The usefulness of the method will be evident to all machine designers interested in stress analysis and efficient design. Its possibilities are limited only by the ingenuity and experience of the worker.

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Developing the Design of Overrunning Clutches

(*Concluded from Page* 25)

from passing the depression, engagement is prevented and slipping occurs. Therefore the prime essential in a lubricant is to guard against too great viscosity, in order to prevent slippage. A light, winter engine oil would fill this requirement for the roller ratchet, but gear rattle and noise is excessive if the same oil is used for the transmission. The selection of a lubricant therefore involves a compromise in viscosity between that required to prevent slipping and that required to prevent gear noise at high operating temperature.

The oil with the flattest viscosity curve is favored, in view of temperature changes that must be encountered and the direct relationship between temperature and viscosity.

Cam Should Be Self-Centering

The immediate future will see this roller ratchet type incorporate the maximum possible number of rollers in order to reduce the unit loading to the minimum. This will decrease wear and result in a mechanism less sensitive to the characteristics of the lubricant. Improved means will be provided to decrease spinning when free wheeling. The cam should be self-centering, to avoid alignment difficulties and unbalanced engagement or disengagement.

I am of the opinion that a multiple disk or plate unit can be built, all of which might be allowed to rotate, while the vehicle is being driven, from the drag of the plates. When braking, the "stationary" member of this unit would be engaged and brought to rest by a lock gear, after which, pressure on the plates would be applied in accordance with the braking demands. The picking-up of the "stationary" member would be easy, and could be facilitated by staggering the engaging teeth of the clutching member. This construction would avoid brake drag. The necessary elements of such a design are locking gears; brake unit, which will also function as a synchronizing clutch; means for preventing reverse rotation; and the various controls. The whole could be co-ordinated into one assembly to provide a free-wheeling unit, a speed synchronizing device for the same, a sprag device and a service brake. The common usage of many of the elements involved should place the accomplishment of this within the ability of the designing engineer. The clutch or brake unit could incorporate a blower, which would of course be inactive when the entire unit is rotating but would come into increasing use as the relative motion beween the two members became greater, to dissipate heat when the unit is used as a brake.

THIS article in the series on relationships of design engineers with other departments and agencies deals with an unusual subject. Believing the relation of the average engineer to the technical press is important, we have asked a number of typical representatives of the design profession to tell us frankly how they regard technical publications.

Their opinions are incorporated in the accompanying composite letter. Criticism is not directed toward any single publication, yet no periodical is free from the implication that its shortcomings account for the opinions expressed.

Next month, in rebuttal, we will present our idea of how technical publications and engineers can work together more effectively.

—The Editors

Bringing Technical Information to the Engineer's Doorstep

By L. E. Jermy
Editor, Machine Design

IN PREVIOUS articles of this series it has been established by authoritative opinion that design engineers profit through cordial and cooperative relations with the personnel of other departments, with sales representatives of other companies and with their fellow engineers through engineering society activities. It is generally agreed that the broadening influence of these contacts is beneficial and important to the average engineer.

Similar opportunities are afforded through the medium of the technical press. Because it is a vital force in the field of industry, it is desirable that engineers understand its function and know how to avail themselves of its services.

Business papers embrace industrial and class publications. Industrial papers are of two kinds —Technical publications, dealing with production, fabrication and application, and merchandising or trade papers, which deal with marketing and distribution. Class publications are those dealing with functions, such as organization, insurance, purchasing, finance, etc.

Business papers came into existence in response to a definite need. In the early days of American industry, knowledge of the various trades was handed down from father to son. But as activity shifted from the home to the small factory and as machines supplanted hand work, the word-of-mouth method of transmitting information became inadequate. Early in the nineteenth century the printed page began to take the place of the spoken word. The page grew to a folder and then to a pamphlet. Progress in industry soon made these reports obsolete and periodical publication was demanded. From this modest beginning the business paper came into being, struggled for early existence and gradually developed into an important force in industry.

During the past quarter-century the character and scope of industrial papers have changed considerably, due in large measure to developments in the industries and professions which they serve. The tendency toward specialization is reflected in the technical press as clearly as in industry itself. The intricacy of the industrial structure of the nation is matched by the complicated and confusing array of its publications.

Every branch of industry is served by from one to 20 magazines. Each important profession is catered to by one or more periodicals. In addition there are numerous class publications which sweep through several industries or professions on functional lines.

The primary purpose of industrial journalism is to aid industry in the various activities identified with the production, distribution and appli-

cation or use of commodities. The principal functions are:

1. To present technical articles and to provide a clearing house for information pertinent to the industry or profession served.

2. To express editorial opinion intended to promote the best interests of the industry or profession served.

3. To gather and publish news of value and interest to readers.

4. To present in advertising pages information regarding materials, equipment, supplies and services required by the industry represented by the readers.

In addition to the foregoing, many publications undertake numerous other functions such as conducting surveys, compilation of statistics, presenting awards for notable achievements, etc.

In this discussion we are concerned only with technical publications and particularly with those of interest to engineers identified with machine design. Periodicals conforming to this description deal largely with articles showing recent developments in the application and use of materials, methods and parts. They also present educational articles intended to review principles of design and to point out new applications of these principles. News of individuals, companies, associations, products, patents, etc. also is presented. Most of the publications

What We Think About Technical M

IN OUR opinion one of the principal factors entering into the attitude of design engineers toward their engineering publications is the excessive number of periodicals published. The superabundance of technical magazines accentuates the problem of selection and makes it difficult for the average engineer to know where to turn for the information he needs.

The number of publications also results in confusing repetition. There are many periodicals containing almost identically the same material. Not only do the professional papers for mechanical engineers contain descriptions of machines and devices, but many publications intended primarily for industry also present the same descriptions.

Sometimes we think that periodicals which supposedly are dedicated to serving specific industries deliberately attempt to branch out to increase their circulation by publishing a small smattering of a few articles which overlap into the field of another periodical. This in itself would not be objectionable if they were able to print new material, but in the majority of cases their editorial content is similar to that found in those periodicals already covering the field upon which they are attempting to encroach.

When young engineers first begin to take their jobs seriously they usually read carefully the few magazines to which they subscribe and tear out, file and index the articles which they consider important. This plan soon proves to be too ambitious; the combination of bad guesses and poor cross-indexing causes the engineers to adopt simpler and more practical systems. Soon they find it is impossible to read all of the literature appearing in their fields and gradually they select favorite publications upon which they can rely to keep them abreast of new developments.

"Confronted by the problem of selection"

Reading the few favorites thoroughly sometimes becomes burdensome, because reading time during working hours is limited and other interests occupy spare time. At this stage the solution for the average engineer seems to lie in scanning the journals which have been found to contain the most valuable material so as to know what information is available and where to find it when the need for its use arises.

The only articles read carefully upon receipt of some magazines are those which have an immediate bearing on problems at hand or which seem to offer new avenues of attack on unsolved problems. The remainder are scanned hurriedly but with sufficient care to grasp the character of their content and then are stored away for future reference.

Believing that the majority of engineers follow this practice, we think that the publishers of technical magazines should give more attention to the reference value of the articles they present. Good indexing, bibliographies, abstracts, synopses and other aids to the reader in "spotting" and selecting worthwhile material for reference usually are highly appreciated.

Now and then there is a tendency to present articles that are so highly technical that they cannot be of service to anyone except a few specialists. This is true of the publications of technical societies more than of periodicals issued by commercial publishing houses.

The other extreme is found in the tendency of certain journals to "popularize" their editorial content by following the lead of the tabloids in presenting only news photos and briefs. On a lazy day the "popularized" technical paper may delude an engineer with the sensation of having touched the pulse of the world's progress, but the articles usually remembered and the ones from which profit is derived are those that analyze problems. The average engineer finds no permanent satisfaction in "frothy" technical publications. He does not object to conciseness; that is an asset. But he does object to brevity if it is achieved through superficiality.

present editorials and publish comments from readers.

The emphasis placed on each of these various classes of editorial material differs with each publication. No two periodicals are alike because with few exceptions, each magazine approaches its chosen field from a different and distinctive angle. Certain publications are intended primarily for the production and operating personnel of the machinery manufacturing industries, yet there is considerable information in these papers of interest to design engineers, purchasing agents, sales managers and executives. On the other hand, a magazine edited specifically for engineers in machine design inevitably also is interesting in part to production men, sales managers, executives, purchasing agents, etc.

This accounts for the emphasis placed by the engineer authors of the accompanying composite letter on the multiplicity of and overlapping of technical publications. It also explains why there is so much apparent repetition of certain editorial material, particularly descriptions of new equipment and parts.

Better understanding by readers of the objectives of technical publications will enable them to select more wisely. Next month we will discuss yardsticks by which technical papers may be judged by design engineers.

Magazines—By a Group of Engineers

Many technical publications could be improved in their appearance and general make-up. This is especially true of the advertising sections, which really are the most important part of many magazines. How often have readers turned to the advertising index, sought the page number of the ad of a company in whose product they were particularly interested, turned to the indicated page and there found instead of the information anticipated only a glorified page card of 1890 form and style stating that the company is manufacturer of a long list of machinery? Why do not more companies devote their advertising space to presenting desired information on new products?

Advertisements not only pay the bill for the publisher but if handled properly they contain most vital information for the engineer. Advertisements should tell the reader just exactly what is available—in some detail—and where it can be obtained. The reading matter and editorials should be and generally are both interesting and instructive, but here again there is room for improvement. Some exceptionally well edited publications do not receive the attention they deserve because they are unattractive. On the other hand, some magazines of so-called *de luxe* appearance are quite superficial. A balance between appearance and quality of text is highly desirable.

Some publishers overlook the instruction value of technical magazines. We believe that the idea of "magazines for executives only" has been overdone in many instances. Publications are for the making of executives and their instruction should be intelligible to the young and comparatively inexperienced as well as to the veteran. In our opinion no publisher of a technical magazine will regret catering to and encouraging those readers who are in the process of rising in the ranks of their profession. There is danger of too much sophistication in some of the technical papers of today.

Editors of engineering publications exercise a greater influence than they themselves realize in shaping the careers of engineers. Alert editors often have been responsible for seeking out an obscure engineer, and through correspondence, encouraging him to put his ideas on paper with the result that eventually he becomes a valuable contributor. This is good for the engineer, for the paper and for the industry.

On the other hand, editors of a few publications rely too much on the contributions of "hack" writers who are more interested in the pay check than in their contributions to the literature of the profession. The appearance of numerous contributed articles from these "professional writers" discourages qualified engineers from contributing and in the end is a detriment to the publication.

"Since the magazine by post has replaced the pilgrimage to the sage!"

We believe editors should encourage writing by engineers in the field they serve. It is an ideal way of stimulating an exchange of ideas and of elevating the standard of the literature of the profession.

Technical magazines reveal our contemporaries to us. A man with whom one of us was associated ten years ago disappeared into an alien industry. This year he wrote two articles which taught us much of value and indicated that our friend has prospered in knowledge for he could not have known of those matters ten years ago.

How economically we learn what other men have to teach since the magazine by post has replaced the pilgrimage to the sage!

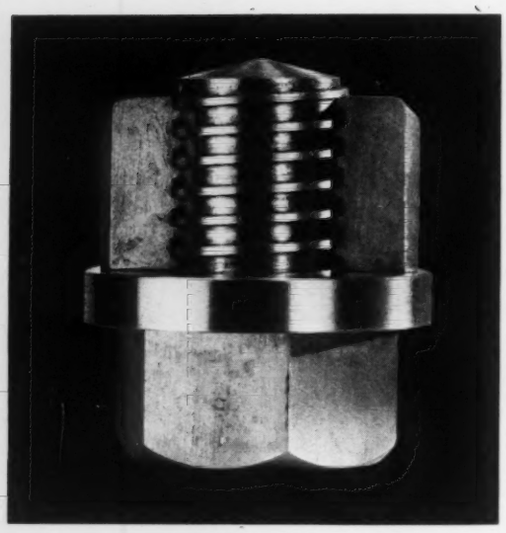


Fig. 1—Threads in locked position, effected when the nut is seated against a resisting surface

Machine Fastenings May Spell Failure or Success

By Harold B. Veith

Editorial Representative, Machine Design

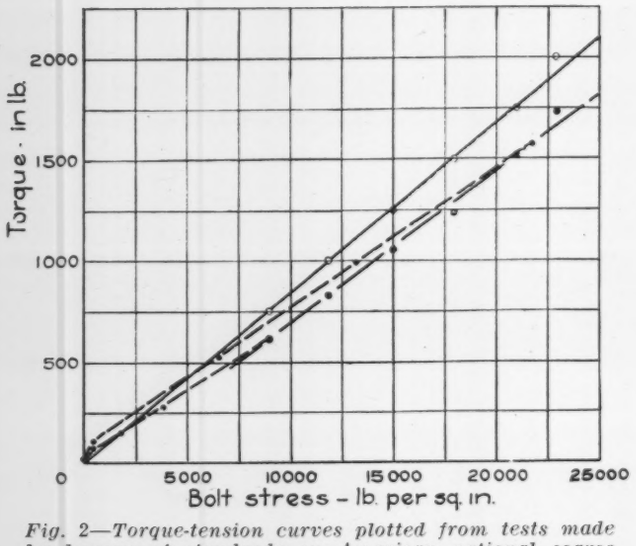


Fig. 2—Torque-tension curves plotted from tests made by bureau of standards on American national coarse thread nut

NOT only may a loose fastening bring inconvenience to a machine operator but serious damage to the machine can easily result if the fastening happens to be the securing means on a fast moving part. For these and other reasons it is well worth the designer's time and effort to consider wisely the various types of locked fastenings which may be applied. A machine may be branded as poor design due to the fact that, although otherwise mechanically sound, fastenings have been given insufficient consideration.

The bureau of standards recently conducted torque-tension tests in which detailed studies were made of individual results from various types of fastenings including standard nuts. Torque-tension curves for the American national coarse thread nut are shown in Fig. 2. Based on Persy's theory the screwing on torque of the American national coarse thread, the U. S. standard nut and the American national fine thread nut should be proportional to the stress, and the initial screwing off torque and the continuous screwing off torque should be the same and proportional to the stress. Curves plotted from the results show that, with accidental variations found in the behavior of the devices, these conclusions are fairly well borne out.

Hundreds of different locking devices have been evolved, some of which will be discussed in the following. Included among them is a group of special fastenings depicted in Fig. 3 through the courtesy of F. A. Firnhaber. These differ from standard devices, being intended primarily for more or less remote applications. They incorporate, however, unique ideas and merit consideration.

Of the numerous commercial locked fastenings there has been developed a screw thread which is self-locking. For application wherever screw threads are used as a fastening, it is adaptable to bolts and nuts, studs, screws, threaded parts of machinery, and many special uses. The locking surfaces of the new thread are the tapered faces at the root of the bolt thread and at the crest of

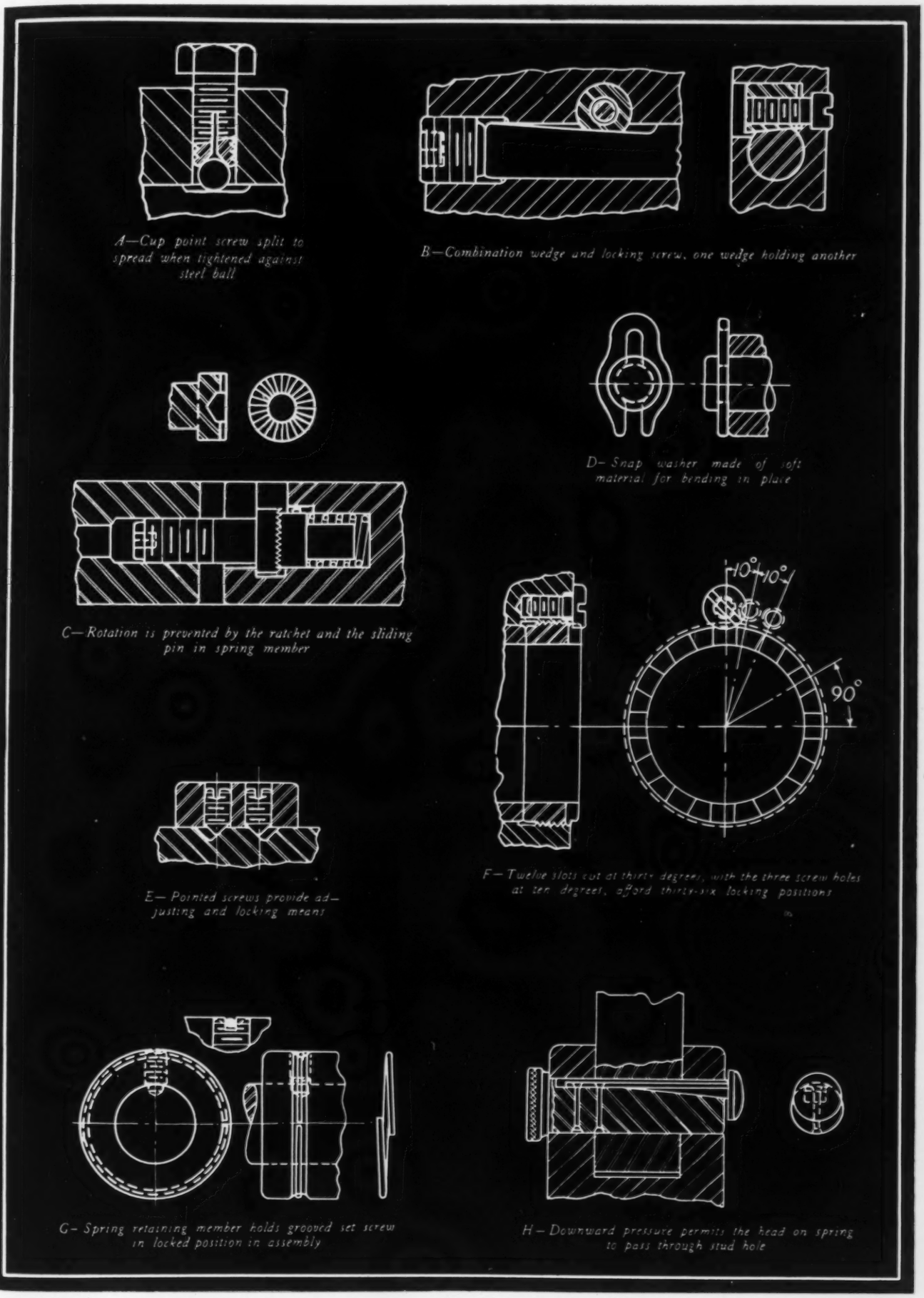

A—Cup point screw split to spread when tightened against steel ball
B—Combination wedge and locking screw, one wedge holding another
D—Snap washer made of soft material for bending in place
C—Rotation is prevented by the ratchet and the sliding pin in spring member
10°
10°
90°
E—Pointed screws provide adjusting and locking means
F—Twelve slots cut at thirty degrees, with the three screw holes at ten degrees, afford thirty-six locking positions
G—Spring retaining member holds grooved set screw in locked position in assembly
H—Downward pressure permits the head on spring to pass through stud hole

Fig. 3—Special locked fastenings employing unique combinations to hold machine parts against vibration or impact

the nut thread, Fig. 1. Until the face of the nut is seated against a resisting surface, the nut is free running. Locking is caused by friction set up by an elastic pressure between the contact surfaces of the tapered faces of the threads of

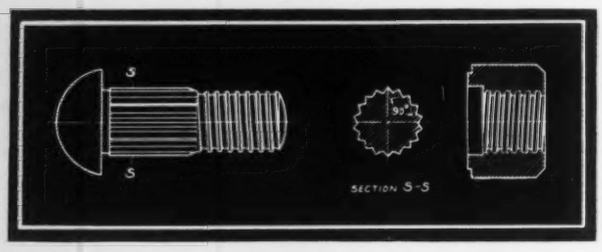


Fig. 4—Rivet bolt with ribbed neck to provide body-bound fit. The thread is of the self-locking type

the bolt and nut. When the nut is seated against a resisting surface and no longer can travel along the bolt, a turn of the wrench forces the tapered face of the nut thread along the corresponding tapered face of the bolt thread with a turning, wedging action until the abutment sides of the threads meet as shown in Fig. 1. These abutment sides carry the major part of the tensile load and prevent the nut threads from being stretched beyond the elastic limit of the metal. When the nut is turned backward pressure is released, allowing the stressed metal to assume its regular form.

An interesting application of this type of thread is on a rivet bolt, Fig. 4, which recently was developed. The neck is ribbed and thus sets up a body-bound fit in the hole when the fastening is driven home. Recessing of the nut accommodates the end of the ribbed section when necessary. Impact tensile tests conducted at Columbia university revealed that the shock resistance of this thread, on headed bolts, is about twice as great for 1/4 to 5/16-inch bolts as that of the U. S. standard V-thread.

The type of locknut illustrated above the standard nut in Fig. 5 has a single thread and is hexagonal, being made from spring steel. It fits standard threads, employing the principle shown in the diagram. The working part is in the form of a coned disk with prongs, the inner circumference of which fits snugly around the root of the bolt thread.

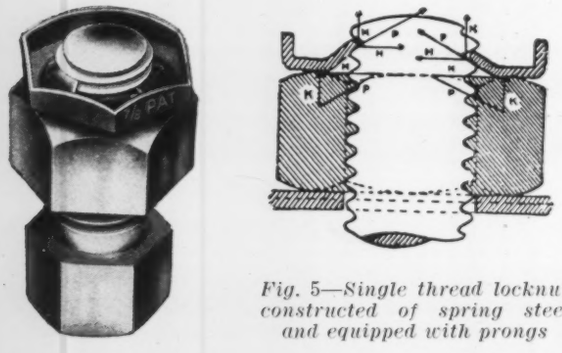


Fig. 5—Single thread locknut constructed of spring steel and equipped with prongs

When the nut is tightened pressure at K-K tends to flatten the prongs, making them grip the root of the bolt thread securely. It is evident from the low angle of the prongs that a pressure along the lines K-K will cause a much greater component force along lines H-H, thus giving the nut a powerful grip in the bolt thread. This device takes no bolt load from the regular nut.

Assembling as a unit a nut and lock washer as depicted in Fig. 6, provides a unique way of eliminating the possibility of bolts and nuts getting into production without protective lockwashers. The lockwasher is fastened over a shoulder on the bolt head or nut, thus enabling it to perform its usual function without becoming separated. This method is adaptable with ease to screws made with rolled threads and upset heads, inasmuch as the undercut shoulder can be produced on the bolt in the upsetting operation. The washers, in assembling are forced or sprung into place on the shoulder.

Where a nut is screwed down, Fig. 7, against

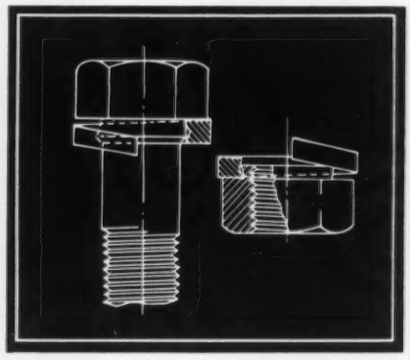


Fig. 6—Lockwasher combined with nut or bolt as single assembly, the washer being held by a shoulder

a resilient member such as a relatively light spring, it must possess characteristics which permit it to stay locked in any position along the threaded length of a bolt, independent of its seating surface. One type of fastening for this purpose is similar to a standard nut except for a fiber ring retained in an inner groove at the top of the threads. The inside surface of the fiber ring is not threaded and is slightly larger in diameter than the bolt at the root of its threads. When the entering bolt reaches the fiber ring it forces its way through, thus forming its own threads in the softer, binding material.

Two bars of ¾-inch thickness held together with ¾-inch U. S. standard stop nuts of the foregoing type were used in a test conducted with the nuts drawn tight and the bars subjected to rapid blows from an air hammer. All nuts remained tight after a considerable number of hours. When the nuts were loosened one turn, and the operation repeated, it was found that they did not move in spite of the fact that seating surface friction was absent.

Another type of locknut consists of two component parts, namely a nut body and an elastic

washer, Fig. 8. The nut body has in its face nearest the work a conical groove, the metal between the innermost face of the groove and the threads being divided into beam-like segments. The elastic steel washer has its outermost face made in the form of a cone, the included angle of which is greater than that of the groove in the nut.

Inner diameter of the helical washer is less than the outer diameter of the slotted portion of the nut; thus when the conical surface of the washer is inserted into the groove in the nut the washer, due to its resiliency, grips the slotted portion of the nut, enabling the nut and washer to be handled as one piece, as shown at left in Fig. 8. Upon tightening, the washer first is compressed axially, that is in the direction of the length of the bolt, until it is flattened similar to the common form of a lock washer. Further tightening causes the washer to be wedged into the groove and by action of the two conical faces to close in radially on the slotted portion of the nut as illustrated at right in Fig. 8.

Fastening Shows Resistance to Vibration

In a test made on this type of fastening the nuts were found to be just as tight after fifteen minutes of vibration as they had been at the beginning, although kerosene had been poured over the nuts during the test. When the nuts finally were taken off it was disclosed that kerosene had penetrated throughout between the nut and bolt, but this had not increased in any way the tendency to loosen.

Flexible fingers of the lower or nut member of a double-nut locking device which has found wide acceptance, are compressed inward against the threads of the bolt with tremendous force by screwing down the upper or locking member. When released, the nut can be unscrewed readily, the threads having been unharmed by the procedure.

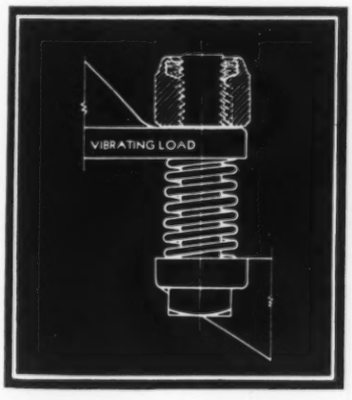


Fig. 7—Stop nut employing a fiber inner ring stays locked in any position along the threaded length of a bolt. Pressure or blows on the seating surface of the nut will not destroy nor cut the threads, provided the load does not exceed the limits of the bolt material

Lockwashers as such comprise a wide and varied selection. Fundamentally they embody practically the same idea, except that some are of the split type with pitched ends and barbs. Others are solid but have twisted teeth around their inner or outer peripheries, which engage the face of the nut and the surface of the work. Spring washers provide features of protection, inasmuch as they afford the spring compensation necessary to overcome contraction and expansion, as well as compensation for wear, stretch or shrinkage in the entire assembly.

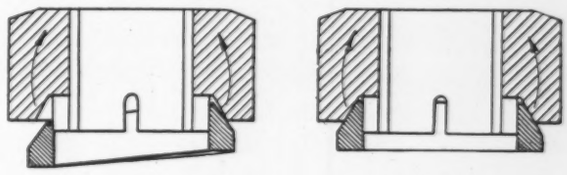


Fig. 8—Combination nut and elastic steel washer, the inner diameter of the latter being less than the outer diameter of the slotted portion of the nut

A self-locking set screw also has been developed which is characterized by an offset at the slotted end. This offset creates a spring tension on the threads, effecting a positive lock.

Close investigation has tended to confirm the opinion of many engineers that although locked fastenings may be considered a comparatively inconsequential feature in design of machinery, otherwise good design may be ruined completely by continuous petty annoyances or serious damage caused by faulty fastenings.

MACHINE DESIGN wishes to acknowledge the co-operation of the following companies in the preparation of this article: Dardelet Threadlock Corp., New York; Drake Lock Nut Co., Cleveland; Elastic Stop division of A. G. A. Co., Elizabeth, N. J.; International Safety Lock Nut Corp., New York; National Lock Washer Co., Newark, N. J.; National Machine Products Co., Detroit; Palnut Co., Irvington, N. J.; Positive Lock Washer Co., Newark, N. J.; Reliance Mfg. Co., Massilon, O.; and Shakeproof Lock Washer Co., Chicago.

POSSIBILITIES of stabilizing large ships by means of a new type thyratron control equipment, utilizing vacuum tubes and a small gyroscope, was demonstrated recently by Dr. E. F. W. Alexanderson, General Electric consulting engineer. Using a small laboratory model he was able to imitate the rolling of a large vessel and show how his device not only would restore the ship immediately to an even keel but keep it stable regardless of wave motion.

The plan incorporates the use of fins, designed like streamline rudders, attached to opposite sides of a ship, or employing force of gravity by changing of weights, which may take the form of pumping water from one tank to another. Movement of these fins is actuated by a small gyroscope, which relays its impulses, amplified by means of the thyratron control, through wires to motors built inside the fins.

Relation of Keyways to Fatigue Failures in Shafts

By R. E. Peterson

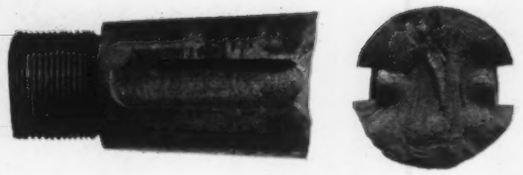


Fig. 1—Typical service failure of a shaft having a profiled keyway

KEYED members constitute an important type of machine element about which insufficient fatigue data are available. The key itself presents no particular fatigue problem. Failures in most instances seem to have occurred in the shafting, rather than in the attached pulley, gear or coupling.[1] Though the primary purpose of keyed shafting is to transmit torque there usually are, in addition to the resulting steady component of shearing stresses, superimposed alternating shearing stresses (reciprocating engine drives) or alternating bending stresses (gear and pulley drives, particularly with overhung shafting). This abstract of a paper, presented at the annual meeting of American Society for Testing Materials, by Mr. Peterson, manager of the mechanics division, Westinghouse Research laboratories, will concern itself primarily with the latter classification, although the conclusions reached have some bearing also on the former classification.

An important point which has been brought out by the tests herein described is that the keyway end is often an important factor in determining failure. Two types of keyway ends are in common use; the sled-runner type, as cut with an ordinary milling cutter of the same width as the keyway; and the profiled type, as cut with an end mill of the same diameter as the width of the keyway. A service failure of a street car drive shaft having a keyway of the latter type[2] is shown in Fig. 1.

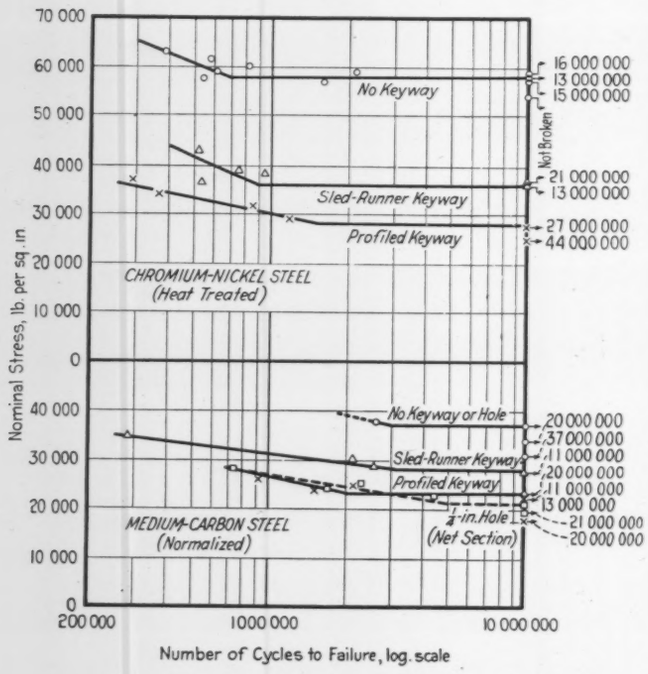


Fig. 2—Graphical comparison of fatigue test data

Two Values Developed

Fatigue test specimens were of cantilever type 1-inch diameter with keyways ¼-inch wide and ⅛-inch deep, Fig. 3. Sled-runner keyways were cut with a 1½-inch diameter cutter. The materials tested were chromium nickel and me-

[1] H. J. Gough, "The Effect of Keyways on the Strength and Stiffness of Shafts," *British Aeronautical Commission Reports and Memoirs No.* 864, 1925. For static tests see paper by H. F. Moore, "Effect of Keways on the Strength of Shafts," Bulletin No. 42, University of Illinois Engineering Experiment station, 1909. For photoelastic tests see paper by A. G. Solakian and G. B. Karelitz, "Photoelastic Study of Shearing Stresses in Keys and Keyways," annual meeting of American Society of Mechanical Engineers, 1931.

[2] Graf, *Die Dauerfestigkeit der Werkstoffe und der Konstruktionselement*, Julius Springer, Berlin, 1929.

dium carbon steel. Fatigue test data are shown graphically in Fig. 2 and the results summarized in Table I. The reason for giving two values of endurance limit is that the (*a*) value is useful for designers and the (*b*) value is of interest to investigators of stress concentration effect.

The final data of Table I are given in terms of stress concentration factor[3], defined as

$$k = \frac{\text{ordinary endurance limit}}{\text{endurance limit with keyway or hole}}$$

Two values of k are also given, corresponding to the (*a*) and (*b*) values of the denominator. Recent tests[4] indicate that fatigue stress concentration factors are not independent of size.

Failures at Point of Tangency

The location of fracture is shown in Fig. 3. The profiled keyways failed in all cases at points of tangency of the semicircular ends, the initial direction of cracking being at a slight angle to a normal section of the shaft. It will be noticed that Fig. 1 shows the same kind of fracture.

From Fig. 3 it will be noticed that the sled-runner keyway did not break at the extreme end of the keyway. The distance from the end varied, being greater in the chromium nickel steel shafts than in the medium carbon steel shafts (average 0.30 inch as compared with 0.05 inch). A chromium nickel steel specimen which had not broken in 10,000,000 cycles was run at a higher stress and developed cracks in two places (0.05 inch and 0.40 inch from the end). In all cases observed the crack started at the outside edge, never at the bottom of the keyway. Just why the crack should start at different distances from the end of a sled-runner keyway is not clear. Unfortunately, the stress distribution at the end of a sled-runner keyway is not known. This is a three-dimensional stress problem and cannot be solved photoelastically. A rubber model may offer possibilities in obtaining an approximate solution[5].

TABLE I

Test Results

	Endurance Limit—Lb. Per Sq. In.		Stress concentration factor	
	(a) Using section modulus I/c for solid 1-in. diameter section	(b) Using I/c based on net section assuming linear stress distribution	(a)	(b)
Chromium Nickel Steel (Heat Treated)				
No keyways (ordinary tapered specimens)	58,000	.....	.....	.....
Sled-runner keyways	36,000	42,800	1.61	1.35
Profiled keyways	28,000	33,300	2.07	1.74
Medium Carbon Steel (Normalized)				
No keyways (ordinary tapered specimens	37,000	.....	.....	.....
Sled-runner keyways	28,000	33,300	1.32	1.11
Profiled keyways	23,000	27,400	1.61	1.35
¼-inch hole (transverse)	12,100	21,000	3.06	1.76

Cases Differ Considerably

Since the end of a profiled keyway is somewhat similar to a transverse hole from the standpoint of stressing, comparative tests were made with medium carbon steel. The stress concentration factors given in Table I—1.35 for profiled keyway, and 1.76 for the hole (both based on net section)—show that there is a considerable difference between the two cases. It was expected that the hole would represent a more severe case, but a smaller difference was anticipated. The above test indicates that the available data in literature on the effect of holes in fatigue may be used safely in the design of the profiled keyways.

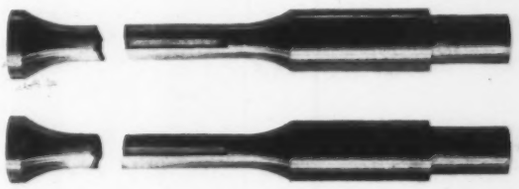


Fig. 3—Test specimens were of cantilever type with both profiled and sled-runner keyways

From the data obtained in the tests it was concluded that:

1. The sled-runner type of keyway is preferable to the profiled type from the standpoint of fatigue. The former has an endurance limit (bending) 22 per cent higher for medium carbon steel and 29 per cent higher for chromium nickel steel (heat treated), the specimens being 1-inch diameter

2. The profiled keyways failed at the points of tangency of the semicircular end. Superimposed constant torque did not change the position or direction of fatigue cracking

3. Tests of specimens having transverse holes ¼-inch diameter showed a lower endurance limit than the profiled keyway, when they are compared on the basis of net section

4. The sled-runner keyways did not fail at the extreme end of the keyway, the distance from the end varying from 0.05 to 0.40 inch

[3]Report of Research Committee on Fatigue of Metals, Appendix. "Present-Day Knowledge of Fatigue," *Proceedings* American Society for Testing Materials, Vol. 30, Part I, p. 298, 1930.

[4]R. E. Peterson, "Model Testing as Applied to Strength of Materials," presented at annual summer meeting of American Society of Mechanical Engineers, 1932.

[5]H. Stoll, "Die Eignung von Weichgummi zum Experimentallen Ermittlung von Spannungsbildern," *Forschung*, Vol. 2, p. 313, 1931.

Investigation by Employment of Models Receives New Impetus

A SYMPOSIUM of seven papers on the use of models in engineering, presented at a recent meeting of the American Society of Mechanical Engineers, serves to emphasize the growing importance of model testing as an aid to design. While the impetus for this method of study has been derived largely from activities in the fields of aerodynamics and hydrodynamics, the practice has spread to many problems closely affiliated with machine design.

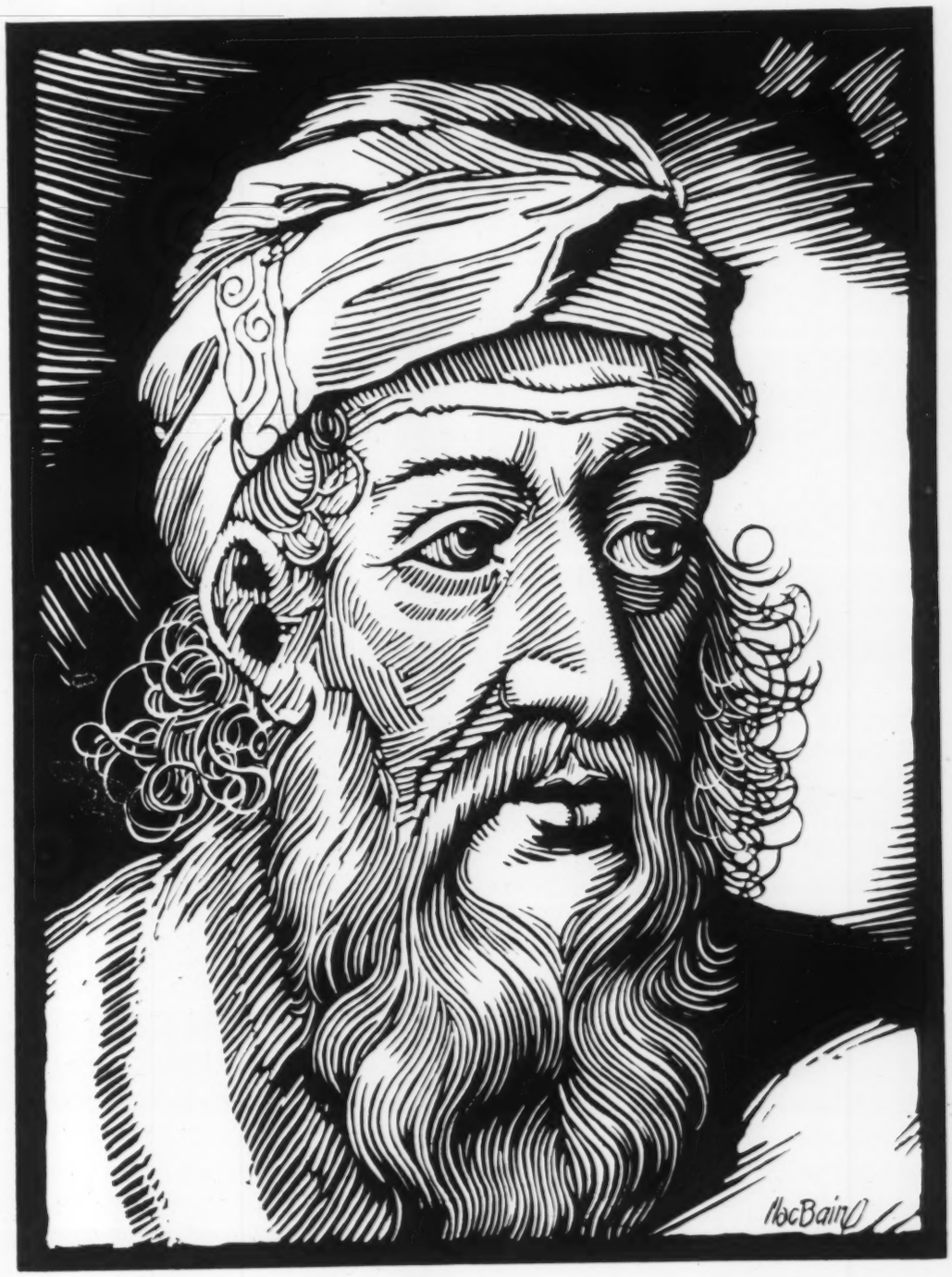
In view of the favorable results reported by those who have gained experience with the use of models, it behooves many engineers to examine the possibilities of this method. The machinery manufacturing industries in the past have spent much time and money on the familiar trial-and-error procedure that could have been avoided or considerably reduced had they known how to study design problems by testing models. Certainly the evidence now at hand shows that in many cases important data is afforded by the observation of models that is not revealed in the ordinary behavior of their prototypes. Much has been learned from models in wind tunnels and water tanks that could not have been derived from tests of airplanes and ships in action.

Engineers dealing with problems of torsion, fatigue, balance, vibration damping and other phenomena of rapidly moving bodies will do well to find out whether or not model testing is adapted to their work. It may lead to new knowledge and to greater economy in investigation.

A Benefit to Design

IN A recent statement by a leading engineer the opinion is expressed that not more than one-third of this year's 10,000 or so engineering graduates will be able to find permanent positions for many months to come; that it would be well worth while for these graduates, wherever possible, to resume their studies with a view to taking either masters' or doctors' degrees and thus not only ease the employment situation for their less fortunate fellows but fit themselves by further study for even higher positions.

With these thoughts we concur heartily. If only a small percentage of engineering students are in the position to follow this course, even at some inconvenience, there will be less necessity for engineering societies and other agencies to try to locate more or less "made" jobs or to institute farming projects and other measures for engineers already in dire straits. And the profession will be benefited by an influx of highly scientific minds at what probably will be a much more opportune time.



Pythagoras

Master Designers

Pythagoras

So dependent is design upon mathematics, that the law of simple numbers is perhaps the greatest single discovery ever made. The complete lack of any geometrical theorems or mathematical data is a condition which cannot be comprehended today. Yet knowledge was in just this state at the birth of Pythagoras, on the island of Samos in 582 B. C., a man who made himself immortal by his personality, one of the strangest and greatest figures in history.

THIS son of a rich Greek won and kept friends. In his studies he learned quickly and soon outshone his teachers. He completed his education by travels over the known world and returned to found a society which was in reality a school of learning. His followers were bound to him with an intense devotion, while the subjects discussed included, in addition to practical mathematics, some mysticism Pythagoras picked up in the East, politics, the basis of numerology and similar subjects.

PYTHAGORAS is best known by the theorem that still bears his name, the theorem which still is difficult for students to prove: in a right triangle the square of the hypotenus equals the sum of the squares of the adjacent sides. The importance of rational demonstration is basic in geometry, and Pythagoras was the first to probe the theorems in an immaterial and intellectual manner. Most of the plane geometry afterward codified in the textbook of Euclid first was developed in the school founded by this genius.

THE system of astronomical relations developed by Pythagoras was the best in existence until the time of Copernicus. He also experimented with musical notes, discovering that vibrating cords develop notes that are dependent on their length. From this was developed his theory of harmonic intervals. The instrument he made to test and prove this theory was the first physical science apparatus ever built.

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments and Questions from Our Readers. Machine Design Will Pay for Letters or Solutions to Problems Suitable for Publication

Force Components in Spur Gear Train

To The Editor:

TIME required to determine the radial loads on bearings, and select them with proper assurance may be reduced considerably by use of the nomograph presented on page 42. Two cases are shown in diagrammatic form along the right side of the chart, one where the spur gears are mounted between their respective bearings and the other showing a driven gear overhanging its bearings. It is equally convenient to determine the force components in either case.

The formulas used in the preparation of this chart are:

$$Q = \frac{HP \times 63025}{n} = \text{torque in pounds inches}$$

Factors employed in the development are:

HP = horsepower transmitted
n = revolutions of shaft per minute
P = force tangential to pitch circle of driving gear in pounds, equal to Q/r, where r=pitch radius of driving gear in inches

$$N = \frac{P}{\cos\alpha}$$

N is the force normal to the area of the tooth contact and the N subnumbers represent the forces on individual bearings. $S = P \tan \alpha$, where α = pressure angle of gear tooth, and S is the force component tending to separate the gears and the subnumbers represent the forces on the individual bearings. Therefore,

$$P = \frac{HP \times 63025}{n\,r} \qquad N = \frac{HP \times 63025}{n\,r\cos\alpha}$$

$$S = \frac{HP \times 63025 \times \tan\alpha}{n\,r}$$

$$N_1 = \frac{N \times A_1}{C_1} \qquad N_2 = \frac{N \times B_1}{C_1} \qquad N_3 = \frac{N \times B_2}{C_2}$$

$$N_4 = \frac{N \times A_2}{C_2}$$

For gear trains involving more gears than are shown, it is necessary to find the resultant forces due to driving the other gears in the train and in turn find the final resultant of these primary resultant forces, either graphically or mathematically.

For problems involving torque only, draw a line through the HP and RPM (n) and read the result where this line meets line Q. P is found by a line through the point on Q through r to line P. From P we can obtain either N or S force component, or both, and the fact that both N and S appear above and below the line need not confuse one—it simply means that one line has been made to serve for both in order to save space. S is found by a line through the point on P through the tangent of the pressure angle to meet the S line. N is found the same way only the line is drawn through the cosine of the pressure angle. Note 1—The true value of N and S are shown horizontally if the angles are written horizontally and vertically if written vertically.

To obtain the resultant S_1, N_1, S_2, N_u, N_o simply draw lines as indicated from the N and S line and read the result on the last line (see Note 1 in the preceding paragraph for values). This last operation is equivalent to multiplying the value of S or N by the number taken on the A line and dividing by the number taken on the C line. To find N_1 and N_2, draw lines from the N point found, 838, through A_1 and B_1 lines respectively to the pivot. From the points found, draw lines through C to the N_1,N_2 line to find the values.

Example, given:

$HP = 30$, $n = 1200$, $r = 2$, $\alpha = 20°$, $A = 3''$
$B = 4''$, $C = 7''$

Resulting in the following:

$Q = 1575.6$ pounds inches $\quad P = \frac{Q}{r} = 787.8$ pounds

$$N = \frac{P}{\cos\ 20} = 838 \text{ pounds}$$

$S = P \tan\ 20 = 286.7$ pounds, $\quad N_1 = 478$ pounds
$N_2 = 359$ pounds

—PAUL R. GUIRL,
Rockford, Ill.

Record Design Progress!

To the Editor:

CONSIDERABLE benefit can be derived from the keeping of a diary during the design period of a machine. Very little effort is required

Complete determination of radial loads on bearings and the proper selection of these bearings may be effected with a minimum loss in time and with compatible accuracy by use of this nomograph. Two typical cases are presented diagrammatically along the right side. Formulas for the nomograph are given on page 41

for this procedure, and the records can be kept in any blank book at little cost. The first entry usually is a list of the various mechanisms deemed necessary to bring the design to a successful conclusion according to specifications. While the design is progressing, various members of the organization may be called together for consultation regarding the design and any changes made at these meetings should be noted and listed carefully.

Explanatory sketches of suggestions made form a permanent record when placed in such a book, and after the design is completed they can be checked over to be certain that nothing has been overlooked. Such a record is invaluable, especially during the erecting and testing period, as it affords a ready reference in case corrections have to be made.

—A. GRIMM,
Pearl River, N. Y.

Co-ordinating Design, Production

To the Editor:

AFTER reading your thought provoking article, "Do Designers Give Sufficient Thought to Production?" in the April issue, I would like to offer a few comments. While I consider the criticism of the too conventional rule-of-thumb type of shop superintendent justified, we have also with us the dogmatic, inflexible minded designer, who, purely interested in creating a theoretically perfect piece of work, fails to recognize that the successful production of his brain-child depends upon the resource of the shop man in handling the equipment available.

Often the designer evolves something which only can be produced profitably by the use of the most modern equipment, and is rather inclined to balk when urged to modify his design to meet the shopman's equipment limitations. I suggest that the designer should always bear in mind that if there be any doubt as to the effective machinability of any of the parts with average tooling, a few minutes' discussion in the shop will clarify the matter. This is better than completing the design and throwing the responsibility on the hands of the shop superintendent.

—ROBERT S. ALEXANDER,
Providence R. I.

Is Engineering Training Too Narrow?

To the Editor:

IN ADDITION to the points on humanizing engineering education noted in the editorial in the May issue of MACHINE DESIGN, there are other points brought out in the bulletin issued by Ohio State university that should interest practical engineers.

One of the statements that is applicable to the entire profession is, "Hitherto engineers may have known that their inventions often created suffering and distress rather than increased well being, but they did not feel that it was in their power to do anything about it. Now, with industrial leaders casting about desperately to find some way of making industry consistently beneficial to the public generally, it is felt to be entirely logical that engineers should interest themselves in the problem of how their inventions can be introduced without creating distress. At least they can make suggestions. Engineers more than other people are expected to get results with a great measure of certainty. Beyond question, not only in dealing with material things but also in developing methods of management, they have shown themselves exceptionally able to produce consistent progress."

These are thought-provoking statements and really deserve the earnest consideration of all engineers. The engineer's habit of analysis surely will be an immense help to this topsy-turvy world. This challenge will certainly be met heroically by all engineers.

—C. E. SCHIRMER,
Springfield, O.

Chart Gives Cast Iron Constituents

CHEMICAL analyses and mechanical properties of nickel cast iron compositions recommended for 49 important applications are furnished automatically by a new composition chart recently compiled. This chart, prepared for the assistance of designers and foundrymen in the selection of suitable alloy compositions to meet special service requirements, consists of a cardboard face plate which rotates over a larger plate having a ring of casting classifications around its periphery. To operate it, the type of casting in which the engineer is interested is selected from the outer ring, an arrow on the face plate is brought to coincide with the position of this classification, and physical properties and chemical composition read through openings in the face plate. The chemical components given are total carbon, manganese, silicon, chromium and nickel, while physical properties include tensile strength, brinell hardness, per cent steel in charge and heat treatment. The back of the chart gives suggestions for variations should the castings be too hard, too soft or too weak, and a table of alloy additions. Copies may be obtained from International Nickel Co. Inc., 67 Wall street, New York.

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

STUDENT of economics and an authority on the application of hydraulics in machinery, John P. Ferris has temporarily forsaken the technical aspect of his profession to devote his efforts to economic problems of government. In order that he might accept the recent appointment of assistant secretary of the Wisconsin executive council and secretary of its committee on business economics, the Oilgear Co., Milwaukee, has granted him leave of absence from his post as chief engineer.

For the past 13 years Mr. Ferris has been engaged in the development of oil hydraulic power transmission machinery for various industries. During nine years of this period, he has had charge of the administration of the Oilgear engineering department and development laboratory. Prior to the incorporation of this company in 1921, he was associated with the development of hydraulic variable speed drives and variable displacement pumps which subsequently were manufactured by it.

Born in 1898 in Philadelphia, Mr. Ferris obtained his scholastic training in engineering at Swarthmore college and the University of Wisconsin. During the World war he served in the ordnance department of the United States army in France. His affiliations include associate membership in the American Society of Mechanical Engineers. He is author of several papers on technical and economic subjects and also is a contributor to MACHINE DESIGN.

INVENTOR of outstanding innovations in newspaper presses and other printing machinery, Henry Alexander Wise Wood now is contributing one of the most important steps in the daily newspaper industry—a four-color system. The initial installation is scheduled to be made in the *Chicago Tribune* plant this coming winter. With this, newspapers can be printed in four colors in perfect register, without make-ready or slowdowns for paper replenishment, at a continuous running speed of 50,000 or more copies an hour.

From early boyhood, Mr. Wood has been associated with the printing industry. He was born March 1, 1866, in New York, and now heads the Wood Newspaper Machinery Corp. It was in 1894 that he decided to leave the field of commercial printing machinery and devote himself to development of newspaper equipment. Six years later he perfected the first automatic printing plate casting and finishing machine.

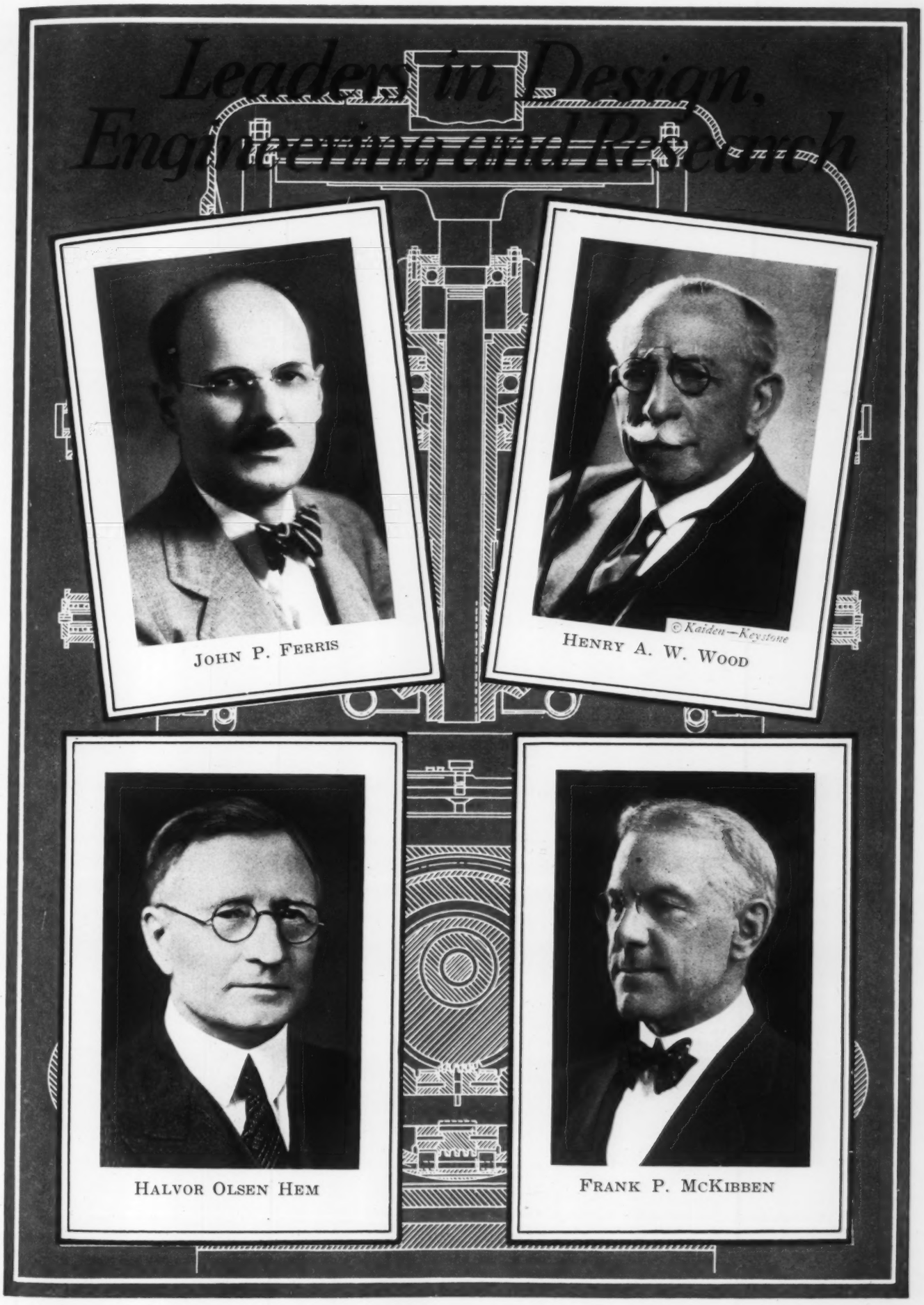
Over 450 patents have been granted to him. Included among these are a series of inventions which he conceived sixteen years ago to double the speed of newspaper presses then in use. The Autopaster for automatic paper replenishment while the presses are running at full speed is one of his more recent developments. Mr. Wood has acquired the habit of dealing directly and realistically with engineering problems . . . and therein lies the secret of his success.

IN RECOGNITION of his ingenuity in perfecting scales of the pendulum type, Halvor Olsen Hem has been awarded the Wetherwill medal by the Franklin institute. This honor marks his record as an engineer. Recently he designed a special automatic scale to measure forces acting upon a full size airplane in a wind tunnel which is claimed to be the first development of its kind.

Joining the Toledo Scale Co., Toledo, O., in 1915, Mr. Hem now is its consulting engineer. He was born in Norway and there received an education in mechanical engineering. Since coming to this country he has become well known in industry and has been granted over 100 patents covering scales and other types of machinery. At the age of 25 he joined the Strait Mfg. Co., Kansas City, Mo., serving as its chief engineer for a quarter of a century.

In the automotive industry his ability has asserted itself in the design of devices for balancing reciprocating parts, and in the mining field Mr. Hem has devised a new system for weighing loaded mine cars.

WELDING has been a subject of paramount importance in the career of Frank P. McKibben, the new president of the American Welding society. As a consulting engineer of international repute he has made a thorough



JOHN P. FERRIS

HENRY A. W. WOOD

© Kaiden—Keystone

HALVOR OLSEN HEM

FRANK P. MCKIBBEN

study of this method of joining metal parts and members particularly in bridge and building construction, and his writings on the technical aspects bear witness of his understanding of the subject.

Graduated from Massachusetts Institute of Technology in 1894, Prof. McKibben served as an instructor and professor in that school until 1907. He then went to Lehigh university as a professor, remaining there until 1919 when he joined the faculty at Union college, Schenectady, N. Y. While lecturing on bridge engineering at these three technical institutions he carried on an engineering practice.

Prof. McKibben designed, equipped and for ten years had charge of the Fritz testing laboratory at Bethlehem, Pa. In 1922, with Ernest Humphrys, he made the first tests on fillet welds in longitudinal shear. He has been active in the American Welding society, having served as senior vice president for two years, prior to his election to the post of chief executive at the recent meeting. In 1931 he was awarded the Samuel Wylie Miller medal for his outstanding work in the development of structural fusion welding.

* * *

A. F. Davis, vice president, Lincoln Electric Co., Cleveland, was elected vice president representing the middle eastern section of the country at the recent annual meeting of the American Welding society.

* * *

James A. Farrell, retired president of United States Steel Corp., was the recipient of the honorary degree of doctor of engineering at Stevens Institute of Technology recently. At the occasion he addressed the graduates of the school.

* * *

P. J. Freeman for a number of years, chief engineer of the bureau of test and specifications of Allegheny county, Pa., has been engaged as consulting engineer by the Pittsburgh testing laboratory, with which organization he was affiliated previously.

* * *

F. O. Clements has been elected president of the Detroit Engineering society.

* * *

Paul W. Litchfield, president Goodyear Tire & Rubber Co., Akron, O., recently received the Spirit of St. Louis medal of the American Society of Mechanical Engineers in recognition of his services to the air industry. The token was presented June 7 at the national meeting of the aeronautics division of the society at Buffalo, N. Y.

* * *

C. H. Kirby, formerly executive chief engineer, has been elected vice president in charge of engineering of Marvel Carburetor Co.

* * *

R. H. Smith recently was appointed manager of the development engineering department of Reliance Electric & Engineering Co., Cleveland.

* * *

S. P. Marley, formerly affiliated with Mellon Institute of Industrial Research, Pittsburgh, now is in the research and development department of Vacuum Oil Co., Paulsboro, N. J.

* * *

Boyd Fisher recently resigned the position of general manager of the National Tool Builders' association. His successor has not been appointed.

* * *

Dr. Charles LeGeyt Fortescue has been awarded the Elliott Cresson gold medal of the Franklin institute. He is a consulting transmission engineer for the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., and has been working for a number of years on methods of simplifying problems.

* * *

George W. Burrell, president of Wellman Engineering Co., Cleveland, received the professional degree of mechanical engineer at the recent commencement exercises at Ohio State University, Columbus, O. He started with the Wellman company in 1898 as a draftsman, rising through subsequent promotions to president.

* * *

Gerald Swope, president of General Electric Co. has been presented the gold medal of the National Academy of Social Sciences in recognition of his constructive social services and his plans for dealing with unemployment.

* * *

D. B. Bullard, vice president, Bullard Co., Bridgeport, Conn., and G. M. Eaton, director of research, Spang, Chalfant & Co., Pittsburgh, recently were appointed by President Conrad M. Lauer to the American Society of Mechanical Engineering standing committee on research which supervises the activities of the society's co-operative research committees.

* * *

French E. Dennison has been appointed chief of small machine design by York Ice Machinery

Corp., York, Pa. He came with the York organization in January to assist in the design and manufacture of small enclosed compressors. Prior to his present affiliation he was employed by General Refrigeration Co., Beloit, Wis., for a period of 10 years in the capacity of chief engineer.

* * *

T. A. Boyd, research laboratory, General Motors Corp., Detroit, has succeeded F. A. Hull, deceased, as chairman of the A.S.A. sectional committee on petroleum products and lubricants.

* * *

Mark L. Lothrop has resigned as president of the Timken Roller Bearing Co., Canton, O. H. H. Timken, chairman of the board, was elected president. Mr. Lothrop has been identified with the Timken company since 1911 when he began as a metallurgist. F. J. Griffiths, president of Timken Steel & Tube Co., Canton, O., has been elected a director of the Timken Roller Bearing Co.

* * *

Blake R. Van Leer, assistant secretary of the American Engineering Council, is announced as dean of the college of engineering, University of Florida, to succeed the late John R. Benton who died in 1930. Widely known for his work in the field of hydraulics, Mr. Van Leer has had 12 years of teaching experience at the University of California where he supervised over 40 research investigations in that field.

* * *

C. A. Rowan has been elected president of the Westinghouse Air Brake Co., Wilmerding, Pa., succeeding A. L. Humphrey, who assumes the newly created post of executive director. Mr. Rowan was previously president of the Westinghouse International Brake & Signal Co., and has been identified with Westinghouse interests since 1894.

* * *

H. J. French who has charge of alloy steel and iron developments for International Nickel Co., New York, has accepted the invitation of the board of directors of the American Society for Steel Treating to deliver the Campbell Memorial Lecture at the annual meeting of the society in 1933. It may be recalled that Edgar C. Bain, metallurgist, U. S. Steel Corp. research laboratories, Kearney, N. J., is to give the 1932 Campbell lecture in Buffalo on October 5.

* * *

Charles le Maistre, secretary of the International Electrochemical commission and director of the British Standards Institution, was honored at a luncheon held in his honor in New York recently. He spent a few weeks in the United States following a seven months' tour of Australia, New Zealand and Canada in connection with an effort to bring about closer co-operation between the national standardizing bodies in the British Dominion and with the British Standards. Institution, formerly the British Engineering Standards association.

* * *

Frank I. Sprague, engineer, scientist, inventor, and pioneer in the application of motors, railways and elevators, is to be honored by a meeting which will be held July 25 at the Engineering Societies auditorium, 29 West Thirty-ninth street, New York. Included in the committee sponsoring the event are all the presidents of the engineering societies and related associations. The occasion will commemorate his seventy-fifth birthday.

Obituaries

ALEXANDER WINTON, pioneer automobile designer and builder, died June 21 at his home in Lakewood, O., one day past his seventy-second birthday. Born in Scotland, he came to this country in his youth. Possessed of an inventive mind, Mr. Winton early engaged in the manufacture of bicycles, turning his talent later to the automobile. Along with Henry Ford and Elwood Haynes, he was one of the first experimenters with autos powered by gasoline engines in the early nineties.

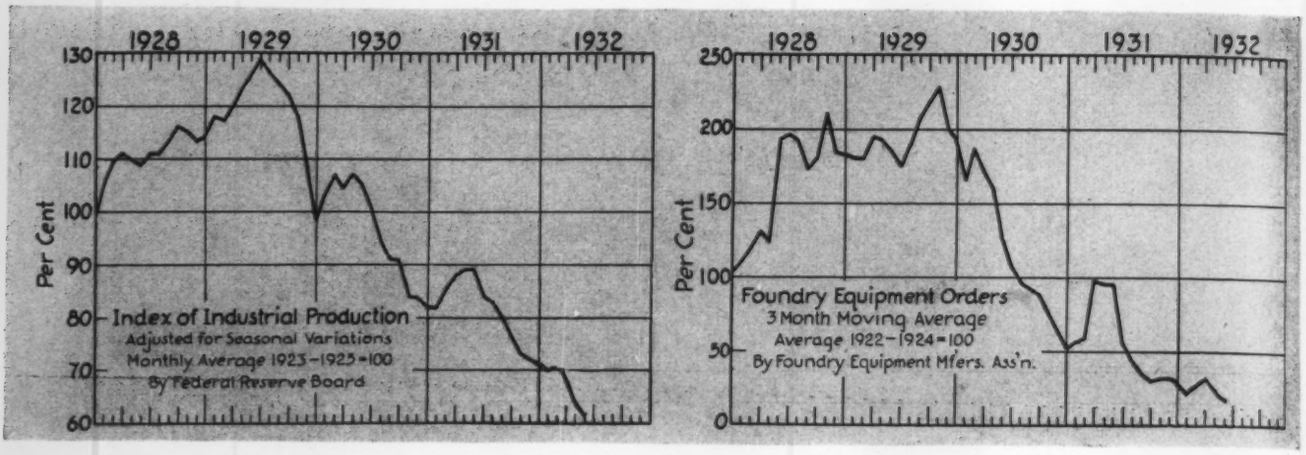
* * *

Robert Miehle, 72, inventor of printing presses and appliances died recently in Chicago. His early inventions formed the basis for organizing the present Miehle Printing Press & Mfg. Co., Chicago. He had been connected with the company until 1914 since which time he had been associated only in a consulting capacity.

* * *

George H. Whittingham, inventor of the automatic motor starter and one of the outstanding contributors to the development of the electrical industry, died in Baltimore on June 4. He was chairman of the board and chief engineer of Monitor Controller Co., Baltimore.

Born March 23, 1867, in New Castle, Delaware, Mr. Whittingham was educated at St. James college, Hagerstown. His first patent on an automatic motor starter was issued in 1889, since which time he had spent practically his entire life in the development of automatic starters and controllers for electric motors. In 1905 he organized, with Wm. C. O'Brien, the Monitor Mfg. Co., which later developed into the present Monitor Controller Co.

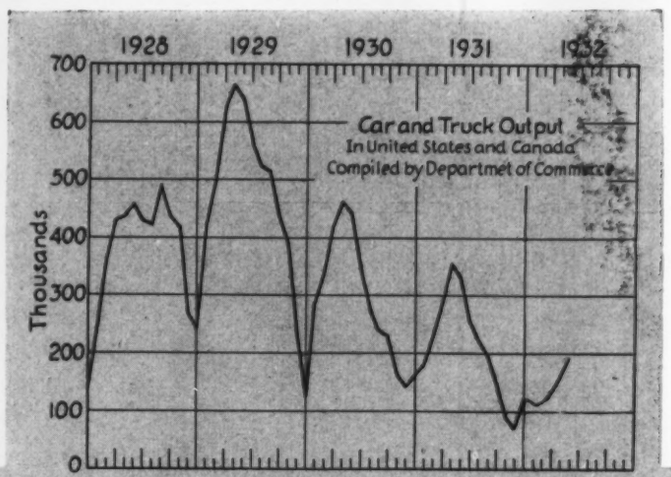


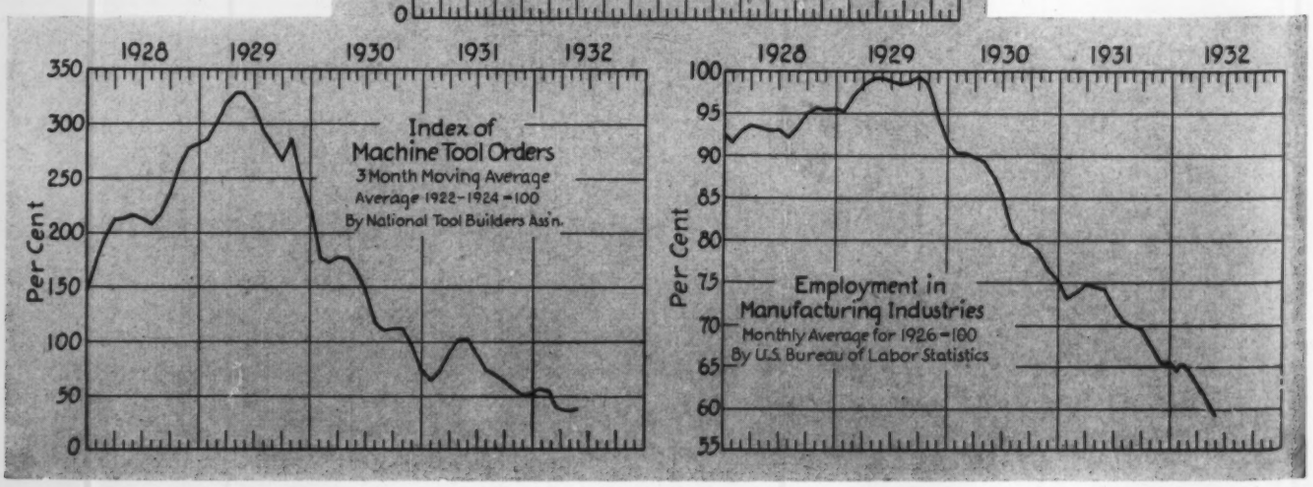
How Is Business?

IF FURTHER evidence was needed to convince the skeptics that a general increase in prices is the factor required to arouse much dormant business, the reaction of the country to the new government taxes should clinch the argument. Every industry to be taxed did enormous business as long-deferred purchases were made.

Not only was a great deal of merchandise sold, but tire factories worked day and night to keep up with the demand, freight loadings jumped to the highest point in months and additional employment was provided for thousands. The rush was so far reaching, that one oil company was reported as being unable to secure enough tank cars to move its products in time to supply all buyers who wished to evade the tax. All this activity was created by what is a comparatively minor increase in price. The amount of business that would be released by definite knowledge of a really worthwhile increase would be gigantic.

Assurance that the nation's budget will be balanced should have a wholesome effect in industry. This has been one of the last straws grasped by those who shout, "Business will not pick up until. . . .," and now that this has been removed, it will be difficult for them to find another excuse for further delaying plans for immediate activity. There is no single development that will retard or accelerate business improvement. One of the vast number of influential factors is the psychological attitude of the buying public. Increasing prices should increase confidence.





NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

MORE versatility is being required of torch cutting machines, a condition brought about largely by the increase in the use of torch cut machine parts in design of various classes of equipment. Indicative of the progress being made to refine torch cutting machines is a new patent covering a unit in which one or more torches can be propelled at uniform speed in any and changing directions in a plane to make cuts of any desired shape. Such machines, James L. Anderson, the inventor, sets forth, have been designed previously to operate in a horizontal plane; however, the idea covered by this patent, was conceived to make it possible to employ a unit of this type for cutting work in a vertical plane also.

The invention in addition embodies means for counterbalancing the movable structure of the unit so that the motor driven tracer is relieved of any undue loading when traveling upward and is not accelerated or caused to slip when traveling downward. This insures evenness and uniformity of movement, essential to clean and accurate cutting.

Numeral 2 in Figs. 1 and 2 designates the base which is designed to rest on the floor when the unit is used for horizontal cutting. Post 3 rises vertically from the base when the machine is placed for horizontal cutting, and extends horizontally when the machine is mounted on support 19 for vertical cutting.

The arm of the machine is made up of an inner section 4 swung on the post, and an outer section 5 connected to the inner section by a pivot joint 6. The arm accordingly can be flexed or extended after the manner of an elbow, and in addition can swing about the principal center, these motions giving all the flexibility required to enable the torch 7 and tracer 8 to move in straight lines, along curves or in angular courses. A magnetic type tracer is preferred, being driven by an electric motor 9 and working in conjunction with template 10 which is applied to the end of the post.

If the machine were supported with the post horizontal, the heavy pendant weight of the jointed arm and of the parts which it carries would make it impossible for the tracer to follow the template and propel the torch at uniform speed. In this new design the difficulty has been overcome by first balancing the arm section 5 so that an average condition is arrived at which allows free motion in all directions without undue loading, and secondly by counterbalancing the entire assembly so that again an average condition is obtained which allows the torch and tracer to move in all directions without tendency to slip at any point.

When the arms 11 and 14 are actuated and

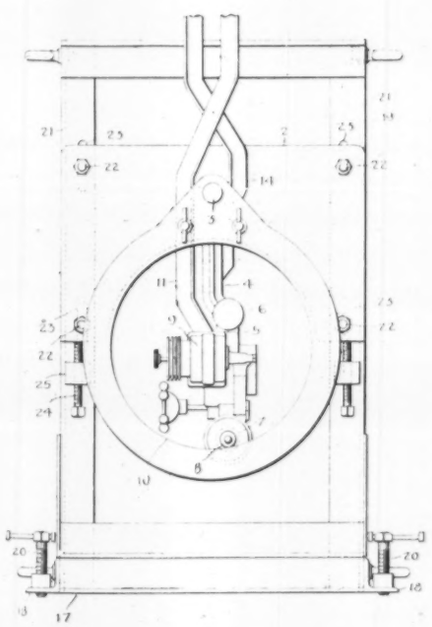
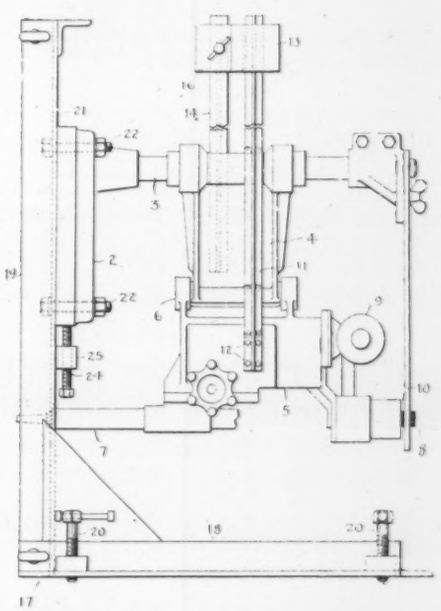


Fig. 1 (Left)—Side elevation of torch cutting machine with which cutting may be performed in a vertical as well as a horizontal plane

Fig. 2 (Right)—Front elevation showing weighted arms employed to counterbalance the assembly preventing torch and tracer from slipping



weights 13 and 16 set properly the movable structure of the machine is balanced so that the unit can operate successfully to cut in the vertical position shown in Figs. 1 and 2.

The patent, which has been assigned to Air Reduction Co. Inc., New York, is designated No. 1,853,026.

CENTRIFUGAL force is utilized in a recently patented clutch to act on steel balls through which driving connection is established between a source of power and a driven element. The device, shown in Fig. 3, was designed by

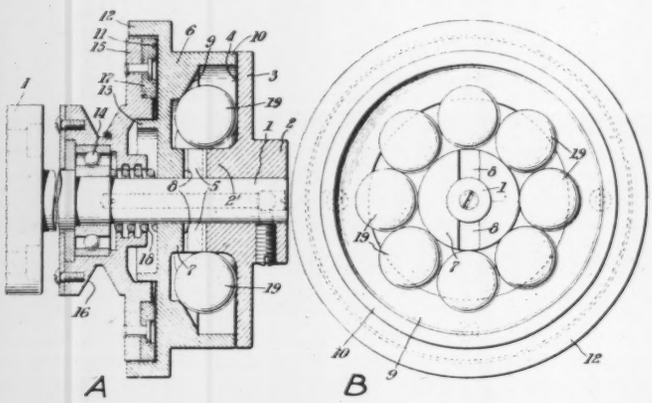


Fig. 3—Balls controlled by centrifugal force actuate clutch members as speed of unit increases, by overcoming resistance to spring

John D. Karle and assigned to Singer Mfg. Co., Elizabeth, N. J. The number of the patent is 1,859,334.

Mounted to slide upon shaft 1 is a driving clutch member 6 having an internal hub 7 formed with diametrical slot-sections 8 which receive rib sections 5. The clutch member 6 also has a ball race 9, an outer cylindrical guard flange 10, a flat clutch face 11, and outer and inner clutch face shield 12 and 13.

In fixed operative position on shaft 1 is mounted the driven clutch member 15 having a belt groove 16 and a friction facing 17 adaptable for friction driving engagement with face 11 on movable clutch member 6. The spring 18, positioned on shaft 1 between ball bearing 14 and clutch member 6, urges the latter away from driven clutch member 15. A series of ball weights 19 is located between conical face 9 and the flat face 4 of the driving members.

When shaft 1 is started clutch members 6 and 15 are out of driving engagement with one another and balls 19 are close to hub 2′. As the speed of the shaft increases centrifugal force exerted by the balls on clutch member 9 overcomes the resistance of spring 18 and moves the part 6 into driving engagement with friction facing 17 on the member 15.

Rib slot key connection 5 and 8 between members 2 and 7 transmits a driving torque from fixed member 2 to movable clutch member 6, operating quietly and without backlash in all positions. Balls 19 are gripped by faces 4, 9 and hub 2′, members 2 and 6 being slightly separated when the balls are in extreme inner positions.

TO COMBAT the perishability of cherries in feeding them from a hopper into a pitting machine, Charles T. Howson has devised a novel brush arrangement for his new unit. A patent covering the pitting machines recently was granted. In Fig. 4 is shown a section through the machine where the cylindrical hopper brush 53 is located. It is this brush which is rotated in the direction of arrow 68 that retards the cherries as they roll down the inclined bottom wall of the hopper. Acting against the cherries, the brush causes them to be fed one at a time from grooves 63.

Pitting pins 32 fastened in crosshead 30, are aligned with the corresponding row of openings 33 in stripper bar 29. Stop plate 65 prevents any cherries being carried upwardly by the brush, while the control plate 64 has its lower edge spaced a distance from the inclined bottom of the hopper so that two layers cannot pass underneath at one time.

Due to the fact that cams on the traverse hopper shaft 52 agitate the hopper and cause it to oscillate slightly on tie rod 15 as its center, there will be a single cherry arranged in each groove 63 ready to be delivered into the next longitudinal row of cavities brought into registration with the grooves.

After the third step-by-step movement of the cylinder or drum in the direction of arrow 66, the cherries will be brought directly beneath pitting pins 32 so that the pits may be removed.

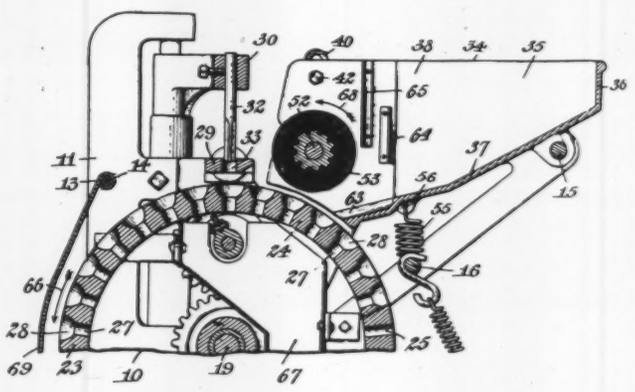


Fig. 4—Cherry pitting machine embodies brush to aid feeding of fruit from hopper without crushing, cherries entering pitter singly

The pitted cherries will be retained in the cavities and carried along to be delivered in chute 69. Huntley Mfg. Co., Brocton, N. Y., is assignee of the patent which is recorded as No. 1,843,283.

AUXILIARY bearing surfaces for sustaining abnormally heavy or oblique thrusts, which however, are inoperative under normal conditions, feature a thrust bearing designed by John

M. English. The unit recently was granted patent No. 1,853,675 and Nice Ball Bearing Co., Philadelphia, is the assignee.

Construction of the part is shown in the section, Fig. 5 *A*. The adjacent drawing shows a modification. End walls 7 of cavity 5 may be regarded as dams projecting from the inner faces of the rings. A circular row of balls 8 are arranged in the pocket provided by the cavity, being held in grooves 6 of rings 1 and 2. A cage for the balls is designated by 9, and 10 is a peripherally arranged band overlapping the rings. Sufficient clearance is provided between band 10 and one of the rings so that the latter are rotatable independently.

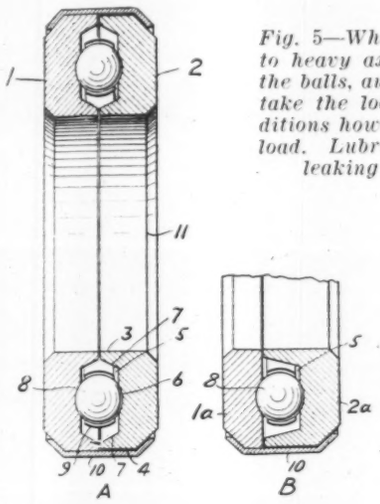


Fig. 5—When bearing is subjected to heavy axial thrust, compressing the balls, auxiliary bearing surfaces take the load. Under normal conditions however, the balls carry the load. Lubricant is prevented from leaking by the construction

Clearance between the proximate dams of the rings when the bearing is not subject to endwise thrust is sufficient to permit free rotation of the rings on balls 8, but without frictional contact between the rings themselves. In bearings of sizes ordinarily used in automobile clutches, this clearance is desirably about .004-inch; thus the major portion of lubricant within the cavity 5 is retained.

Because of the elasticity of the balls and races it is apparent that when the bearing is subjected to heavy axial thrust balls 8 and races 1 and 2 will be compressed slightly. When this occurs the clearance between the opposed faces of dams 7 of the respective rings is taken up and the faces thus are brought into contact to sustain a portion of the load and prevent further compression of the balls.

Review of Noteworthy Patents

Other patents pertaining to design are briefly described as follows:

MASTER PERFORATOR—1,852,202. The principal object of this invention is to produce a punching machine in which means are provided for catching the disks ejected by the punches and conveying them away from the operating point so that they cannot get into the mechanism. One of the features of the arrangement is a revolving spiral brush. Assigned to Electromatic Typewriters Inc., Rochester, N. Y.

SYNCHRONOUS SELF-STARTING MOTOR—1,864,650. A synchronous self-starting motor equipped with a stator having means for producing a progressive magnetic field. Geometrical pole members of the rotor revolve within a ring. Assigned to Hanson Mfg. Co., Princeton, Ind.

HYDRAULIC TRANSMISSION—1,864,568. This patent covers a combined hydraulic transmission and clutch. When the ports are opened fully the driven shaft is at rest and when the ports are closed the shaft is driven at the same speed as the housing. Assigned to S-W Hydraulic Laboratories, Hamilton, O.

MACHINE FOR MAKING SPIRAL CONVEYORS—1,850,886. This invention relates to improvements in machines for making spiral conveyors, incorporating means for forming the spiral or helical flight from bar or strip stock and winding or wrapping it about the central shaft of the conveyor. Assigned to Link-Belt Co., Chicago.

UNIVERSAL JOINT—1,861,364. The general purpose outlined in this patent is to provide a universal shaft coupling comprising essentially a sleeve-like member which encircles the adjacent ends of two shafts to be coupled together. Assigned to Treadwell Engineering Co., Easton, Pa.

Research Publications

Technical News Bulletin. May issue includes reports on volume changes in cast iron during casting, mechanical properties of white metal bearing alloys at different temperatures, factors affecting the physical properties of cast red brass and other investigations. Published monthly by Government Printing office, Washington. Free.

Symposium on Rubber. This book, composed of 12 papers presented at a regional meeting of the society, makes available for engineers, concise and usable technical information on rubber and many of the important engineering materials in which rubber is used. The authors, while authorities in their fields, have written the papers to reach engineers rather than rubber technologists. Published by American Society for Testing Materials, 1315 Spruce street, Philadelphia. 160 pp. $1.75.

Thermal Expansion of Heat Resisting Alloys (Nickel Chromium, Iron Chromium and Nickel Chromium Iron Alloys), by Peter Hidnert, bureau of standards. This paper presents data on the linear thermal expansion of the alloys between 20 and 1000 degrees Cent. With the aid of the data it is possible to select heat resisting alloys which have the same coefficients of expansion for a given temperature range as other materials and to predict the coefficients of expansion of similar new alloys. Published as RP 388 by Government Printing office, Washington. 36 pp. 25 cents.

The Flow of Air Through Circular Orifices in Thin Plates. by Joseph A. Polson and Joseph G. Lowther. The purpose of the investigation was to verify and to extend the existing data on the flow of air through square-edged orifices in thin plates. Published as bulletin No. 240 by Engineering Experiment station, University of Illinois, Urbana, Ill. 37 pp. Free.

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

STARVATION of the nation would follow the abandonment of mechanized agriculture and a return to the hand tools of a century ago, Leonard J. Fletcher, Peoria, Ill., president of the American Society of Agricultural Engineers, declared in an address before the twenty-sixth annual meeting of the organization at Ohio State university recently.

Engineering advances on the farm, he asserted, were a contribution greater than the abolition of slavery, and depression is not a lasting consequence of the machine age. He denied that increased leisure will result in the downfall of the world's workers, and predicted that agricultural engineering will bring about the orderly development of agriculture as an industry with an organization abreast of the great technical advances facing all industries. Mr. Fletcher foresees the complete transformation of farming to a scientific basis with resultant higher standards of living for city, town, and country.

* * *

Hall of Science Dedicated for Exposition

ON JUNE 1, exactly one year before the opening of A Century of Progress Exposition—Chicago's 1933 World's Fair—a celebration centering about the dedication of the Hall of Science, a huge nine-acre structure, was held at the exposition grounds. The dedication took place in the presence of scientists, representatives of foreign governments, business and civic leaders, with Dr. Frank B. Jewett, New York, chairman of the science advisory committee of the National Research council, and president of the exposition, Rufus C. Dawes, as the principal speakers. Elsewhere Chicago celebrated World's Fair Day with observances in schools, clubs, business and civic organiaztions.

* * *

International Standards Are Discussed

EIGHTEEN nations sent engineers to represent them at the series of technical conferences held recently at Milan, Italy. The purpose of the meeting was to secure international uniformity in standards for airplane and automobile parts, cutting tools, iron and steel, etc.

The conferences were held under the auspices of the International Standards association which includes in its membership the national standardizing bodies of the United States, France, Germany, Italy and 14 other nations. Ernest Woller, chief engineer, Timken Roller Bearing Co., Canton, O., an American delegate, discussed before the conference on ball and roller bearings, the American proposal for bearings to replace the thousand different types and sizes now manufactured in the United States alone.

* * *

Spring Research Report Is Published

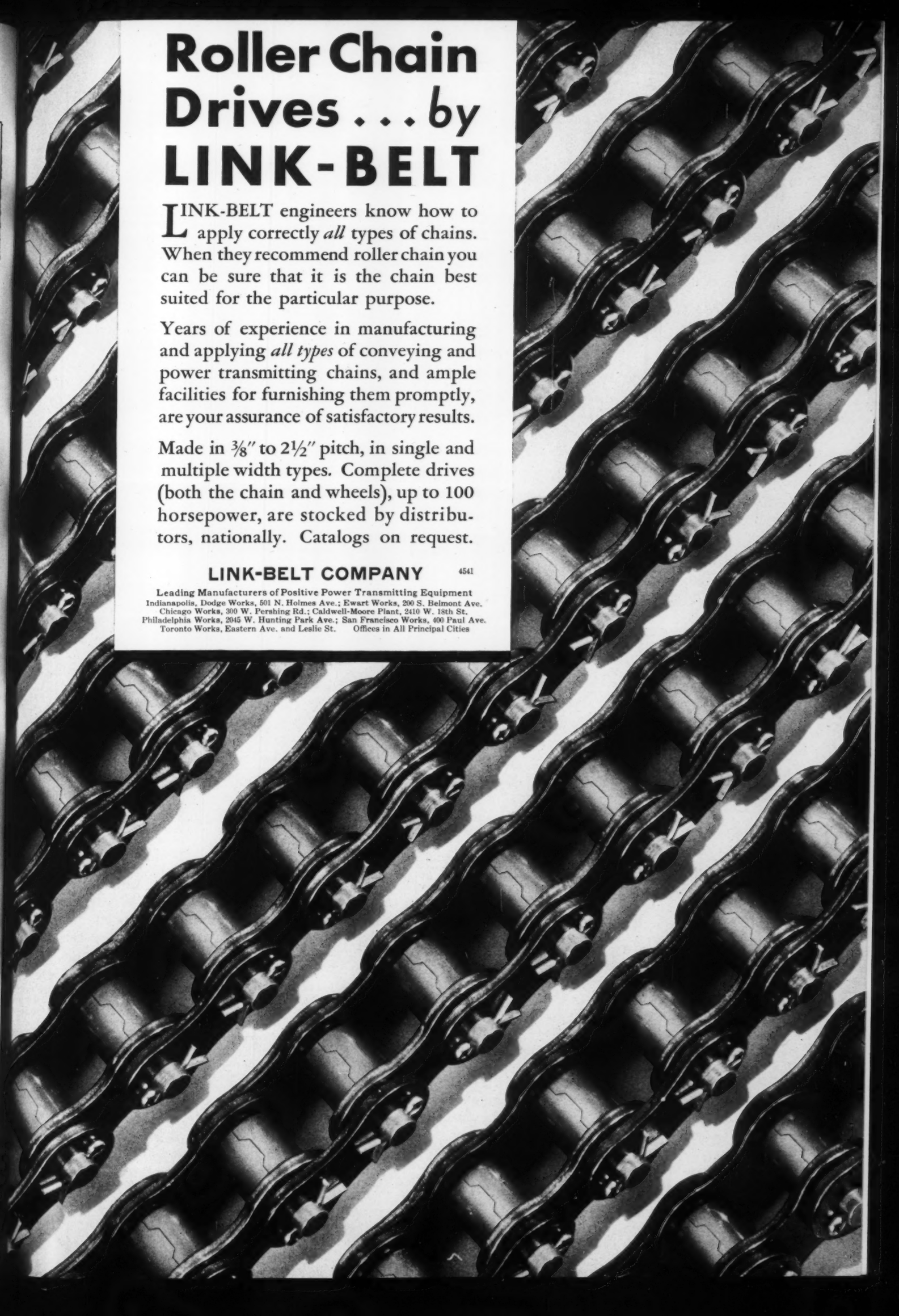
SUPPLEMENTING data on springs, which is constantly being made available to designers, is the report of the springs research committee of the Department of Scientific and Industrial Research. This is a general compilation prepared by the body which was appointed in 1922, since when it has carried on a considerable number of researches on specific subjects.

The report contains a summary of the results obtained or the conclusions reached in these projects. Also included is a bibliography on the subject, a list of published papers and information dealing with researches carried out. The complete survey is obtainable from the British Library of Information, 270 Madison avenue, New York.

* * *

Awards Made in Welding Competition

CHECKS "written" by the arc welding process on ⅛-inch sheet steel recently were presented to winners of the first three awards in the arc welding prize competition sponsored by Lincoln Electric Co., Cleveland. Lieut. Com. Homer N. Wallin and Lieut. Henry A. Schade, both of the United States navy, collaborated on the paper which won the first prize of $7500. Second prize of $3500 was taken by Major G. M. Barnes, an army officer who is chief of design and engineering, ordnance department, Watertown arsenal, while the third prize amounting to $1500 went to H. H. Tracy, structural engineer of the Southern California Edison Co. Ltd., Los Angeles. A jury under the direction of Prof. E. E. Dreese, Ohio State university, examined the entries from which 41 winners were selected.



Roller Chain Drives . . . by LINK-BELT

LINK-BELT engineers know how to apply correctly *all* types of chains. When they recommend roller chain you can be sure that it is the chain best suited for the particular purpose.

Years of experience in manufacturing and applying *all types* of conveying and power transmitting chains, and ample facilities for furnishing them promptly, are your assurance of satisfactory results.

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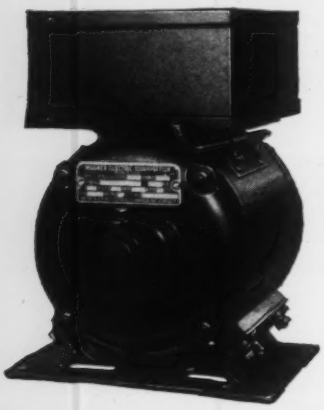
NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

Adds Line of Capacitor Motors

SUPPLEMENTING its other lines of single phase motors, Wagner Electric Corp., 6404 Plymouth avenue, St. Louis, now is offering a line of capacitor motors known as type RZH. These motors, shown herewith, are of the condenser-start, condenser-run, split phase type, with condenser capacity varied from start to run by means of a switch and an auto transformer. In appearance they differ from other motors made by the company in that a box is mounted as an integral part on the top of the motor to accommodate the condenser and auto transformer. The motors are available as rigid or rubber mounted motors, drip proof or totally enclosed.

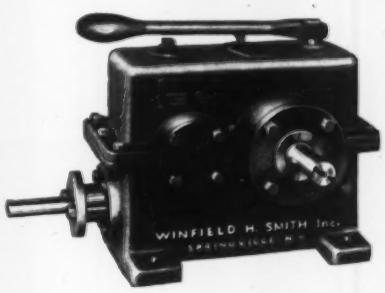


Line of single phase capacitor motors has condenser capacity varied from start to run by means of a switch and an auto transformer

Reducers Have Neutral Position

TWO-SPEED reducers designed to meet the needs of conveyor and other manufacturers who require a change of speed in their drives have been introduced by Winfield H. Smith Inc., Springfield, Erie Co., N. Y. Ratios of reduction can be furnished ranging from 4:1 to 150:1. An important feature of construction is that a neutral position is provided whereby the mechanism operated by the slow speed shaft can be stopped without shutting off the power to the unit.

This speed reducer, shown herewith, has a hardened steel worm on the high speed shaft, driving a special alloy bronze worm gear mounted on the intermediate shaft. On this intermediate shaft are also mounted two spur gears which are in constant mesh with two spur gears mounted on the slow speed shaft. The drive is taken by means of a clutch engaging with one of the spur gears on the slow speed shaft. This clutch is actuated by a yoke arm extending through the top of the reducer to which a shifting arm is attached. The design of the clutch is such that the unit can be shifted from slow speed to high speed operation or to a neutral position while operating under load.



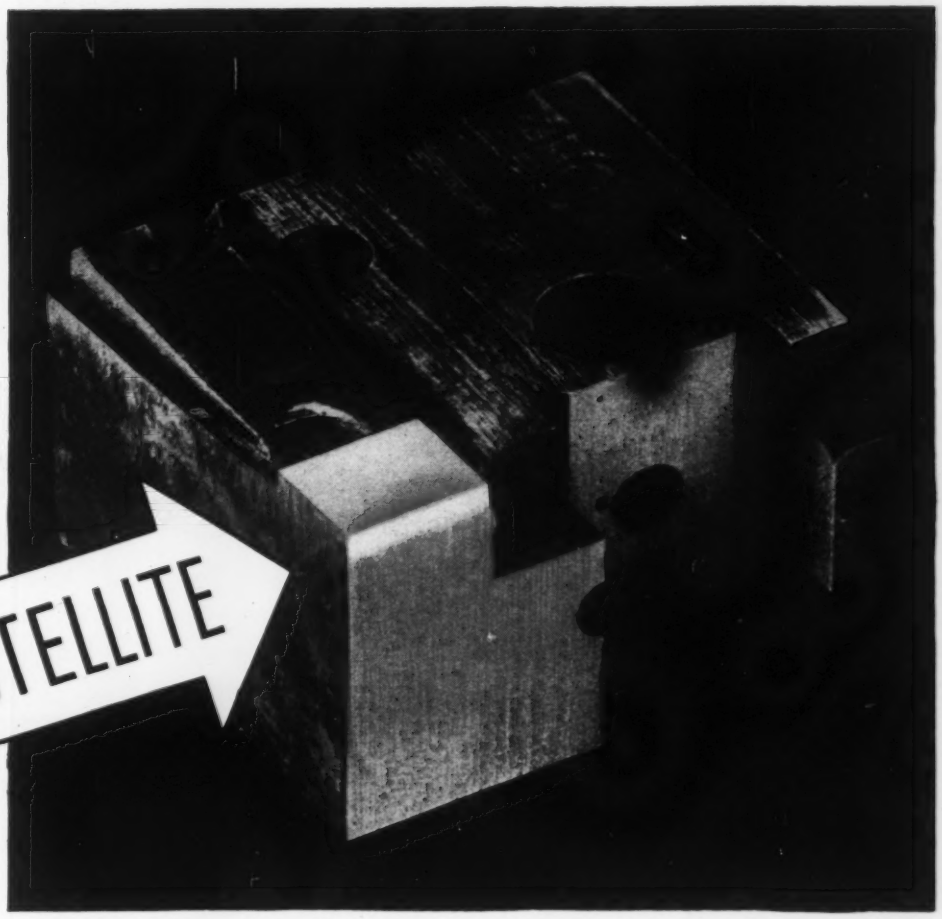
Drive in two-speed reducers is taken by means of a clutch engaging with one of two spur gears on slow speed shaft

Develops New Engineering Bronze

HIGH tensile strength comparable to that of low and medium carbon steel is available with a new engineering bronze, known as Herculoy, developed by Revere Copper & Brass Inc., 230 Park avenue, New York. This alloy can be worked hot easily, is drawn and forged readily, and can be welded with rod of the same material. It is extremely ductile, nonmagnetic and has a rich golden color. Resistance to corrosion approximating that of pure copper is offered, and it is said that the alloy will withstand the attack of a wide range of corrosive agents.

Welding Nipples Eliminate Templates

SHAPED welding nipples which eliminate all templates when saddling one pipe upon another have been developed by Midwest Piping &



● *Extreme accuracy throughout its entire service life is essential in this type-mold. Haynes Stelliting keeps it accurate five times longer.*

For Improved Products and Better Satisfied Customers

THE longer your product's service life, the better your customers will like it. The part Haynes Stellite can play in multiplying the life of metal exposed to heat and abrasion is excellently illustrated in the type blocks made by a prominent monotype company.

Three blocks like the one shown form the mold into which the molten type metal is poured. The raised corner regulates the height of the type. Made of steel, a block lasts only one year. But when the corner is Haynes Stellited, its life is increased approximately five times.

Haynes Stelliting these blocks is a standard production operation because it pays big dividends in customer-satisfaction.

Haynes Stellite's great hardness, which it retains even at red heat, is inherent, and is not the result of heat treatment. Easily and economically applied with the oxy-acetylene blowpipe, Haynes Stellite outwears plain steel three to ten times.

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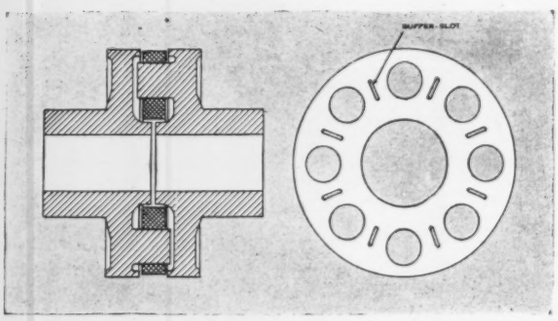
Haynes Stellite Welding Rods and information on other Haynes Stellite Products also are available through the 42 apparatus shipping points of The Linde Air Products Company

Supply Co. Inc., St. Louis. The nipple is placed in position before the opening is cut in the pipe upon which it is to be saddled; the correct opening then is traced easily and quickly from the nipple contact line. Both 90 and 45 degree nipples are made from standard weight and extra heavy wrought steel pipe and wrought iron pipe; sizes are from 1¼ to 12 inches inclusive. On special order they can be provided with any type of forged lap or flange while other angles, lengths and sizes also are available. Both the shaped end and the square end are beveled for welding.

Coupling Flexibility May Be Varied

EMPLOYING a radically new principle, buffer slots, the flexible coupling designed by Brown Engineering Co., 123 North Third street, Reading, Pa., will compensate for any reasonable amount of angular or positional misalignment. The slots are cut at regular intervals in



Cross sectional view of coupling which employs buffer slots to take shock

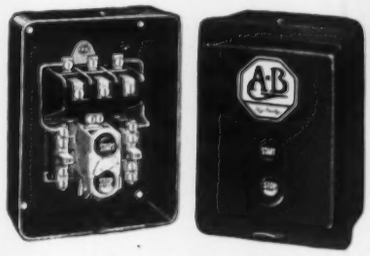
the flexible leather center piece, shown in the accompanying illustration, and the flexibility of the coupling can be varied through wide limits by varying the length and width of the slots.

Under parallel misalignment and shock loads the slots close evenly all around to relieve the strain and provide shock absorption properties for the protection of gear teeth, ball bearings, etc. Angular misalignment closes one side of the slots as they are flexed in opposition to the misalignment. When the load returns to normal, the slots reopen.

Small Switch Gives Overload Protection

A NEW, compact, manually operated switch that will start and stop small alternating current motors and give overload protection has been designed by Allen-Bradley Co., 1311 South First street, Milwaukee. This new Bulletin 609 switch has two overload relays. The tripping of either relay opens the contactor and completely disconnects the motor from the line. Either relay, after tripping, can be reset without opening the switch cabinet.

The switch consists of five parts—a terminal block, a movable contactor arm, the operating button mechanism, and the two overload relays. Pushing in the "Start" button moves the contactor arm upward with a quick snap, causing it to make contact with the overhead terminal block, thereby connecting the motor to the sup-



Hand operated alternating current starting switch gives overload protection

ply line. The tripping of either overload relay disengages the contactor arm from the "Start" button and forces the contacts apart by spring pressure. The "Stop" button is also the reset button for the relay; pushing it in resets the tripped relay and re-engages the contactor arm with the "Start" button, so the switch now can be reclosed by pushing in the "Start" button.

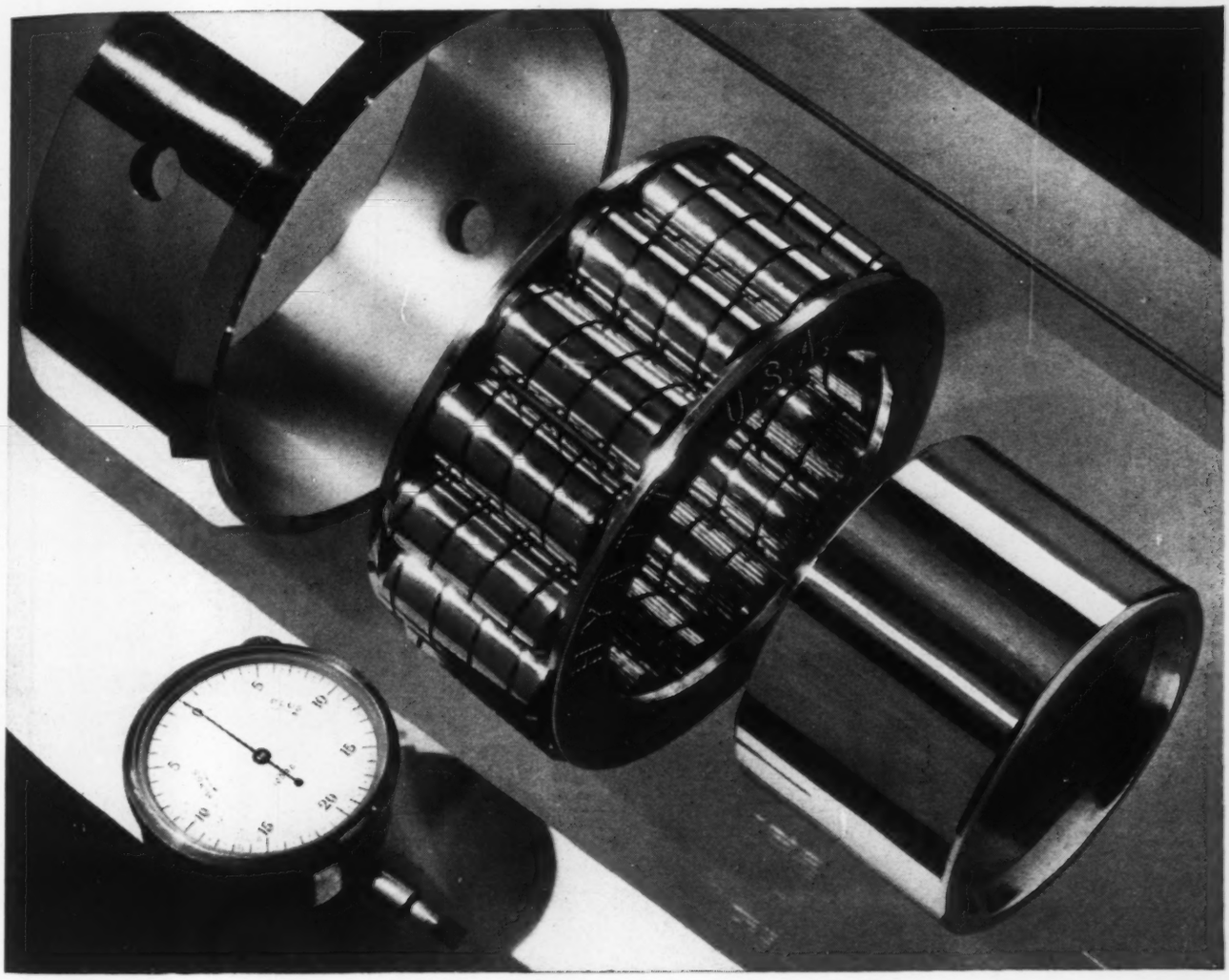
This switch is made in two sizes. Size 1, which is the smaller, has three poles, and Size 2 has three and four poles. The Size 1 switch will handle self-starting single phase motors up to 1 horsepower, 110 volts, and 2 horsepower, 220 volts, and polyphase motors up to 2 horsepower at 220, 440, and 550 volts. The Size 2 switch is rated at 5 horsepower, 220 volts, and 7½ horsepower, 440 and 550 volts, for 2 and 3 phase motors.

Offers Starter for all Requirements

FULL voltage starters for squirrel cage induction motors in a complete line for sizes up to 1200 horsepower, all switches conforming to NEMA requirements, are now being offered by General Electric Co., Schenectady, N. Y. Size 2 and size 3 magnetic switches are now rated as follows: Size 2: 15 horsepower, 220 volts, 25 horsepower, 440 and 550 volts; size 3: 25 horsepower, 220 volts, 50 horsepower, 440 or 550 volts.

The switches, shown herewith, include the new thermal overload relays which follow more closely the heating characteristics of the motor than did previous types. Relay heaters on the first four sizes are now interchangeable as regards mounting dimensions. Enclosing cases for the various switches are similar in appearance and all forms are available in cast iron or boiler plate case for installation in dusty or

DEFINITE CONTROL OF



QUALITY

Production of Hyatt Roller Bearings is so carefully controlled that definite quality is consistently maintained. Every Hyatt Roller Bearing, no matter what or where its use, has absolute assurance of dependable performance built right into it. Small wonder they serve so well and so long. Hyatt Roller Bearing Company, Newark, Detroit, Chicago, Pittsburgh, Oakland.

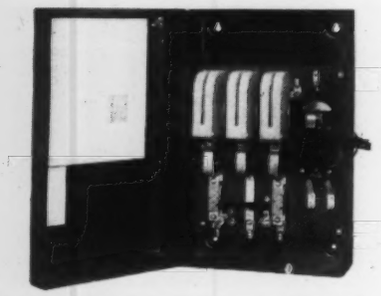
HYATT

ROLLER BEARINGS

PRODUCT OF GENERAL MOTORS

damp atmospheres. Likewise, any magnetic switch in the line can be obtained in form suitable for oil immersion where the installation atmosphere is corrosive. Explosion proof switches, approved by the Underwriters, are available for Class I Group D where hazardous conditions are encountered.

The line of combination switches using a magnetic switch and a fusible or nonfusible motor circuit switch has been augmented by a device

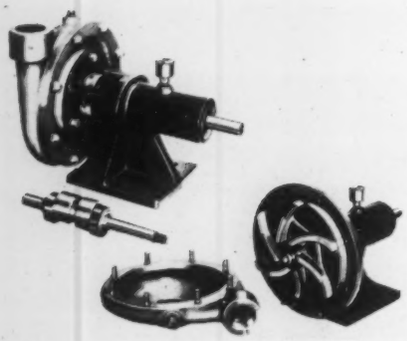


Magnetic alternating switch with thermal overload relays. Maximum rating, 50 horsepower 600 volts

rated 25 horsepower, 220 volts, and 50 horsepower, 440/550 volts. These combination switches use the same thermal overload relays that have been incorporated in the standard full voltage starters. Any of the combination switches can be obtained with test jacks, if required. All forms and sizes of these full voltage starters are available in cast iron, dust tight enclosing cases.

Develops Acid-Resisting Pumps

SHAFT and impeller alignment is accomplished by providing ball bearings to carry the load in any direction in the new centrifugal pumps developed for handling chemicals, liquid foodstuffs and other uses by Hills-McCanna Co., 2349 Nelson street, Chicago. Not only does this



All parts in new centrifugal pumps are made to gage and are interchangeable

construction lengthen the life of the pump, but it permits unusually close tolerance in fitting the impeller in the housing.

All parts are made to gage and are interchangeable. Any of them that come in contact with the liquid can be made of any machineable ferrous or nonferrous alloy. Pumps are carried in stock made of acid-resisting bronze, monel metal, pure nickel, Hills-McCanna No. 45 alloy, No. 55 alloy, No. 50A alloy and close grained cast iron.

The stuffing box is of the split screw gland type which permits proper seal with minimum pressure and easy packing. There is no bearing at the back of the packing. Inboard and outboard heads are removable, an important feature when handling fluids that are highly corrosive, as it is necessary only to replace the heads and impeller. Pumps, which can be furnished with motor drive, are made in three sizes with capacities from 5 to 100 gallons per minute, requiring motor horsepowers from ¼ to 2.

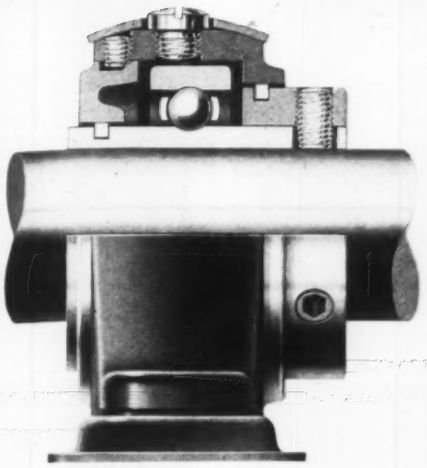
Motorized Speed Reducer Is Compact

TO MEET the demand for a compact arrangement in speed reduction units, Millholland Corp., Indianapolis, has developed a series of motorized speed reducers. Perhaps the outstanding feature of this development is the ability to use a standard motor without special bearings, special shafts or end bells, and yet obtain the

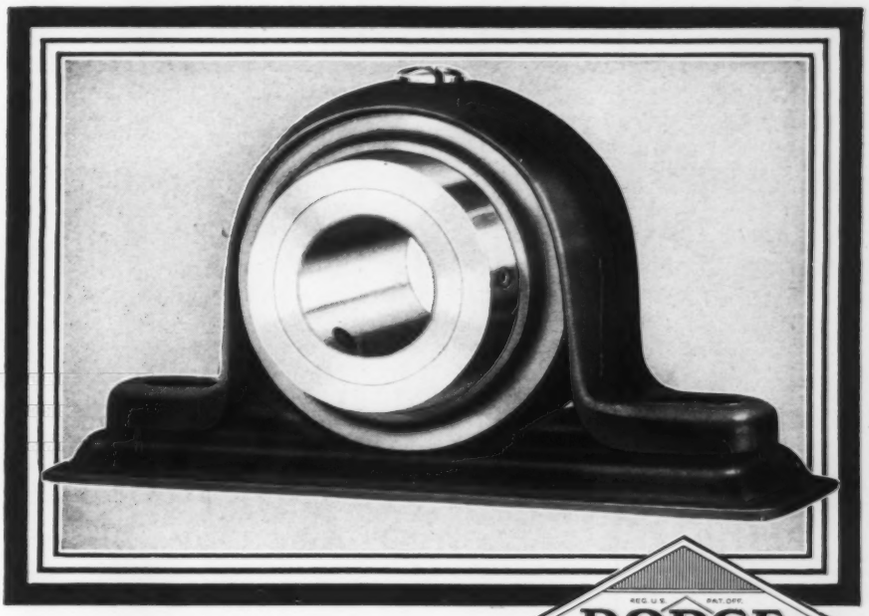
Reduction unit can use standard motors without the use of any special equipment and yet obtain worth while space saving

equivalent, in space saving, of a special geared head motor. This is accomplished by bolting the reducer case directly onto the machined register of a standard motor end bell.

These reducers are of the worm and worm gear type with the worm and worm gear shaft mounted in antifriction bearings. The worm is supported in such a manner that no unusual strain is induced in the motor bearings. The design provides for an outboard foot support to the reducer. Hollow leveling thimbles, through which the reducer hold down screws are placed, are provided in the outboard support feet to accommodate variations in the center height of the motors. The output shaft can project in any of four positions in two planes. This position



Cross sectional view of Dodge Type "DH-1" Ball Bearing Pillow Block showing details of construction



DODGE

TYPE DH-1

You will find All of the features you want in this Pillow Block·

Cut Costs in 1932 with modern Industrial POWER DRIVE and Bearing UNITS by

IF YOU are now using babbitted bearings because you have not been able to buy an anti-friction bearing with all of the features it should have at a price that would not seriously affect your costs, you need do so no longer. You can incorporate Dodge Type "DH-1" Pillow Blocks (with Hoover Ball Bearings) in your product at a price you can afford to pay and with full assurance that you are giving the user every desirable and necessary feature that an anti-friction bearing of the light duty type should have.

This new Dodge bearing is fully self-aligning—it offers full radial and thrust capacity and also provides for expansion. The grease seals used are of the piston ring type providing positive protection against leakage of lubricant or admission of dirt. They are metal and will last forever. The bearing is factory adjusted and very easy to install. The formed steel housing is exceptionally strong and rigid. It is lighter than cast iron and has smaller overall dimensions. It is split, which is an additional feature of convenience.

The Dodge Type "DH-1" Pillow Block will add to the appearance and salability of your product and will give your customer added value and service. It is backed by the engineering and manufacturing experience of an organization of bearing mounting specialists and the world-wide reputation of Dodge for quality bearing units.

Send for our new Bulletin A-117 which gives full information.

DODGE MANUFACTURING CORPORATION, MISHAWAKA, INDIANA

REG. U.S. PAT. OFF.

DODGE

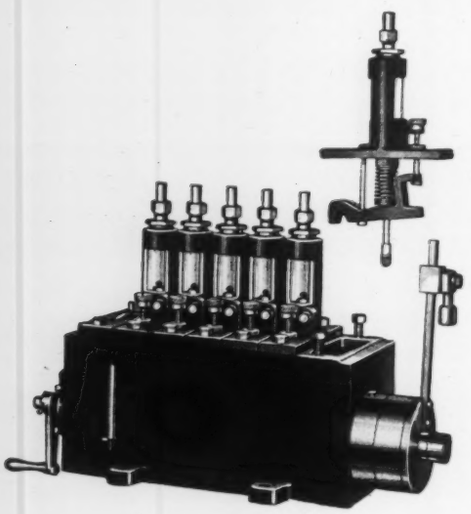
MISHAWAKA

may be changed in the field without the use of special tools.

A number of different case sizes of the same basic design are offered. These are made to fit all standard motor frame sizes from the ¼ to the 10 horsepower size, with maximum reduction in most cases of 60:1.

Lubricator Uses Any Type of Drive

FORCE feed lubricators equipped with liquid-filled sight glasses are a recent development of W. F. Bowser & Co. Inc., Fort Wayne, Ind. A single plunger serves the dual purpose of drawing the oil from the reservoir and forcing



Pumping units on new lubricators are adjusted individually and are removable while equipment is in operation

it in a straight vertical path through the sight glass to the point of lubrication at the end of the feed line.

Each pumping unit is adjusted individually and is removable while the lubricator, shown herewith, is in operation. A simple method of refilling the sight glasses has been incorporated in the design; a standard lubrication fitting permits injection of the liquid by means of a grease gun. The new unit can be furnished with any type of driving mechanism required.

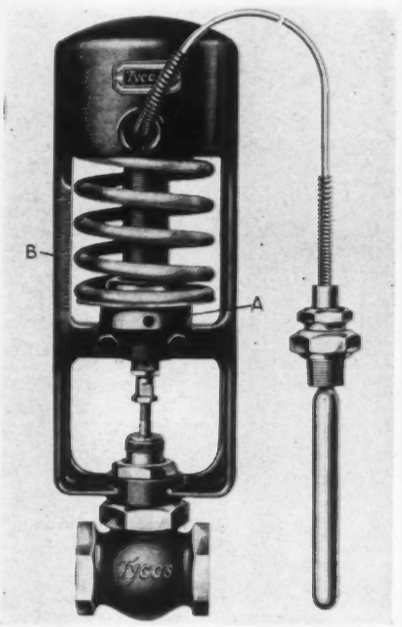
Lights Indicate Temperatures

TEMPERATURE signal devices for determining temperature by means of electric lights, known as Thermo-Tel, have been developed by Uehling Instrument Co., Paterson, N. J. The instruments consist of different colored electric lights actuated by temperature changes. When the temperature is within the limits for which an instrument is set, a white light will illuminate, when it is above the limits, a red light will illuminate, and when it is below the limits, both lights will be out. Each signal is set for the particular limits desired, for example, 190 and 193 degrees. If desired, the signaling lights may be located any distance from the temperature which is being observed. The signals are accurate to within less than one tenth of one degree Fahr., and can be read at a distance of 200 feet.

Regulator Has Unique Tube System

BY RADICAL changes which have removed undesirable features, Taylor Instrument Cos., Rochester, N. Y., have developed a new self-acting temperature regulator of unusual accuracy and sensitivity, thereby opening new fields for its use. The most important improvement in the device, shown herewith, is the practical elimination of friction.

A feature which contributes a great deal to



Tube system in self-acting temperature regulator consists of a double seamless bellows, extra-heavy walled copper connection tubing and stainless steel bulb of small size and thin wall

the performance of the regulator and its adaptability to the greatest variety of applications is the construction of the tube system. This consists of a double seamless bellows, extra heavy walled copper connection tubing and stainless steel bulb of exceptionally small size and thin wall.

This tube system requires a minimum volume of actuating medium which makes a small bulb possible, and, together with the thin wall of the bulb and its shape, results in a tube system that responds quickly to temperature changes. Of considerable value also is the over-

IS *Life* JUST A BOWL OF RASPBERRIES?

When well-designed equipment goes haywire in your customers' hands, who gets the blame? Your customers' employes? Well, sometimes.

More often the blame is tossed right in your lap as the designer. Then life indeed becomes a bowl of raspberries.

Why not forestall such situations by definitely specifying Alemite Specialized Lubricants for the Alemite equipment you design into your work? Many designing engineers are doing this purely for the sake of self-protection.

You have found or you WILL find that even the efficiency of Alemite High Pressure Lubrication Systems is nullified when shoddy, gummy, acid-content "greases" are employed. For there is no compromise with lubrication. It is either all right or all wrong!

We anticipate your request for complete information on Alemite from your standpoint as a designer.

Alemite Corporation, (Division of Stewart-Warner). 603
2644 N. Crawford Avenue, Chicago, Illinois
Gentlemen: I am interested in information regarding Alemite Systems and Lubricants from the designer's standpoint.

Name .....

Company .....

Address .....

City ..... State .....

PIONEERS IN SPECIALIZED LUBRICATION FOR INDUSTRY

ALLEN

TRI-MARKT

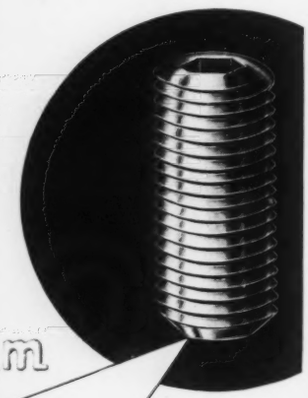
TRADE MARK

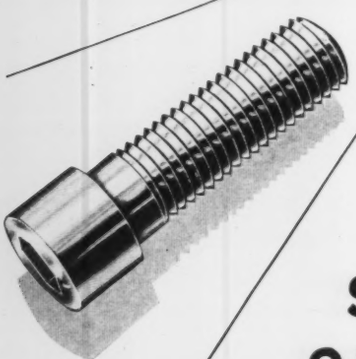
HOLLOW SCREWS

of

Chrome-

Mo-lyb-den-um





50% more strength

25% more hardness

than former ALLEN Screws

CHROME-MOLYBDENUM STEEL with a *special heat-treatment* provides material for the new Allen screws surpassing in strength and practical economy any hollow screws commercially obtainable. Now available in the popular sizes; milled from the bar, with cut threads multi-checked for accuracy. Each screw hand-inspected; every one a GOOD one; a new screw if you break one. Write for samples—ask also for new Catalog.

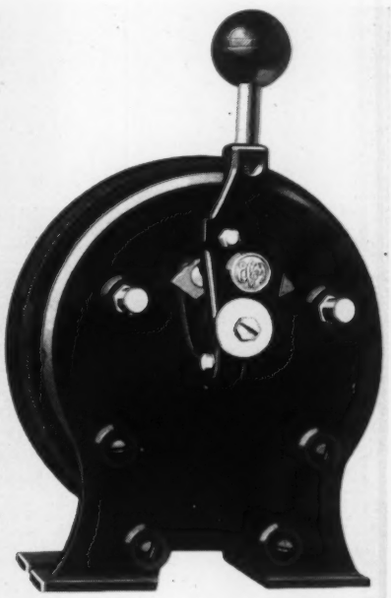
THE ALLEN MFG. COMPANY

HARTFORD, CONN. U. S. A.

heating feature of the tube system which permits heating the bulb beyond the upper limit of the range of the instrument without injury.

Master Switch for Controllers Designed

A MASTER switch known as type NX, the function of which is to regulate the control circuits of a magnetic controller has been designed by Electric Controller & Mfg. Co., 2696 East Seventy-ninth street, Cleveland. The device is intended for use where a maximum of three points of speed control in either direction is required. Applications for which the unit is particularly well adapted include roller tables



Magnetic controller master switch is for regulation where a maximum of three points of speed control in either direction is required

and other steel mill drives, bridge and trolley motions of small cranes and small hoists equipped with the Wright dynamic lowering circuit magnetic controller.

As shown in the accompanying illustration, this master switch is entirely enclosed by a sturdy steel cover and has an aluminum frame. It may be mounted in an upright or inverted position; the operating handle is provided with tapped holes for mounting the handle vertically or horizontally as desired.

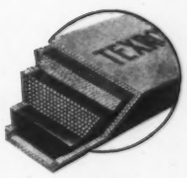
Motor Is of Laminated Construction

STEEL laminations and cast side plates are employed in the construction of a new small squirrel cage motor, for fans, moving picture projectors, small unit heaters and similar equipment, designed by Automatic Products Co., 121 North Broadway, Milwaukee. A reinforced

Shock absorbing

TEXROPE MULTIPLE V-BELT DRIVES

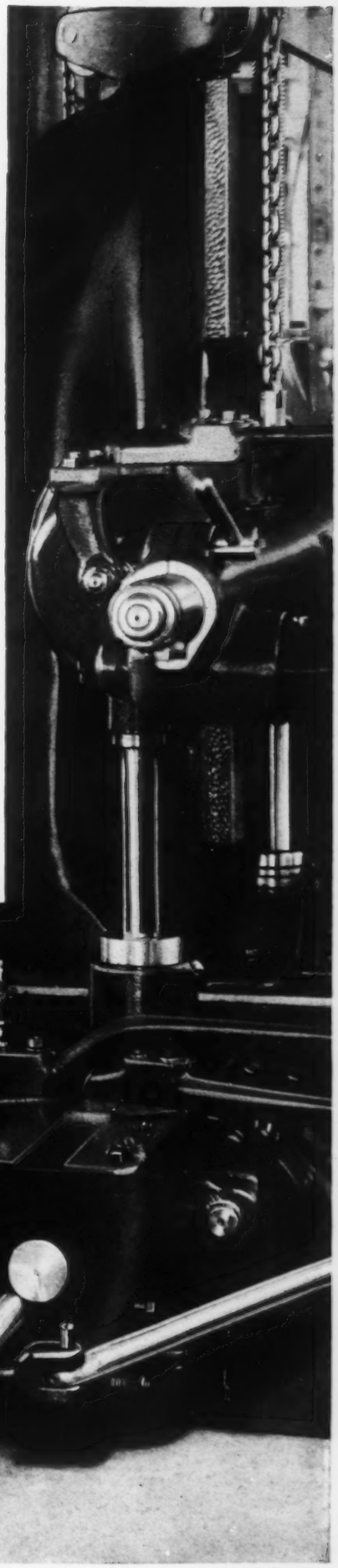
are highly economical in first cost . . . in operation . . . and in maintenance. Texrope Drives are economical because of the little space they require . . . because of their high efficiency . . . and because they operate without oil or grease. Texrope Drives are economical because they are easy on bearings . . . because they protect machinery by absorbing shocks . . . and because they do not require frequent attention. These and other economies are illustrated in Texrope Bulletin 1228-K. You may have a copy by writing to Allis-Chalmers Mfg. Co., Milwaukee, Wis., or the nearest District Office.

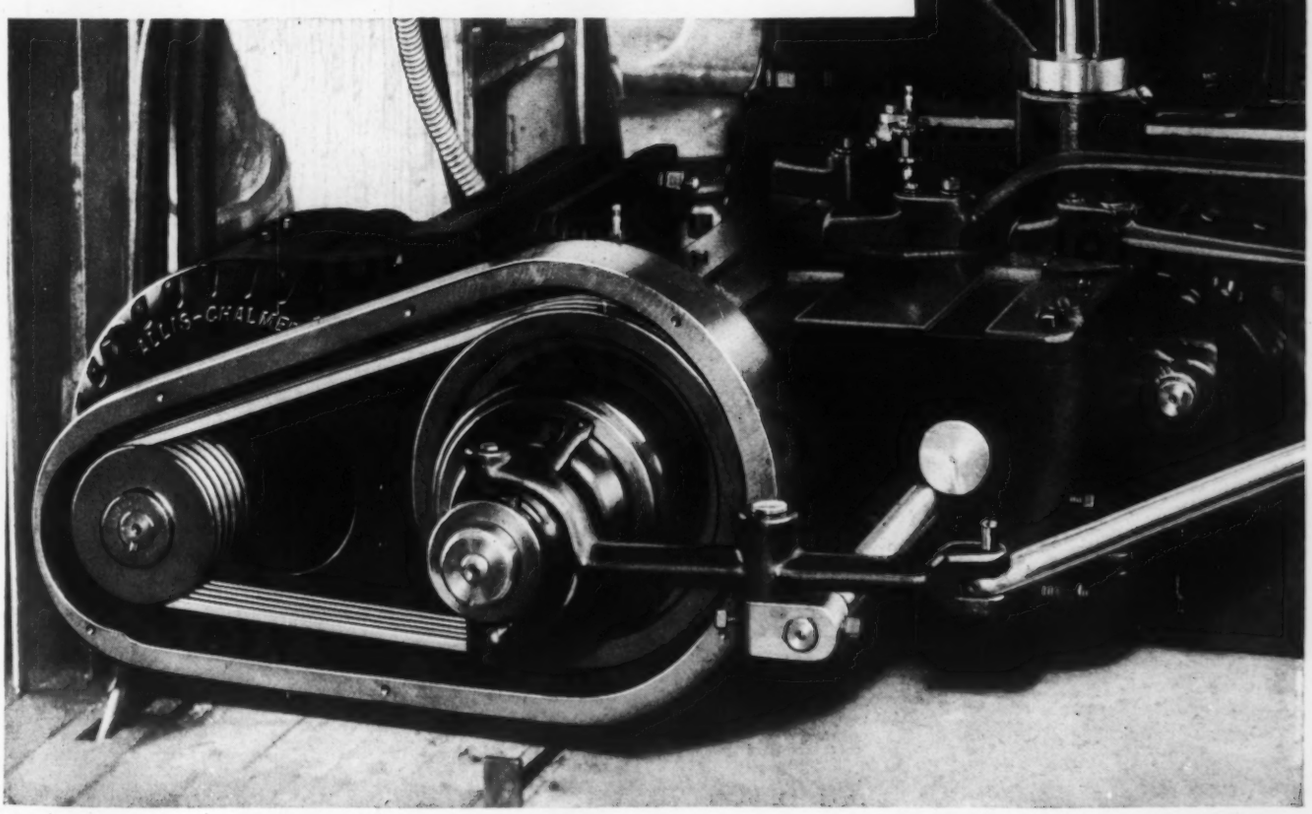


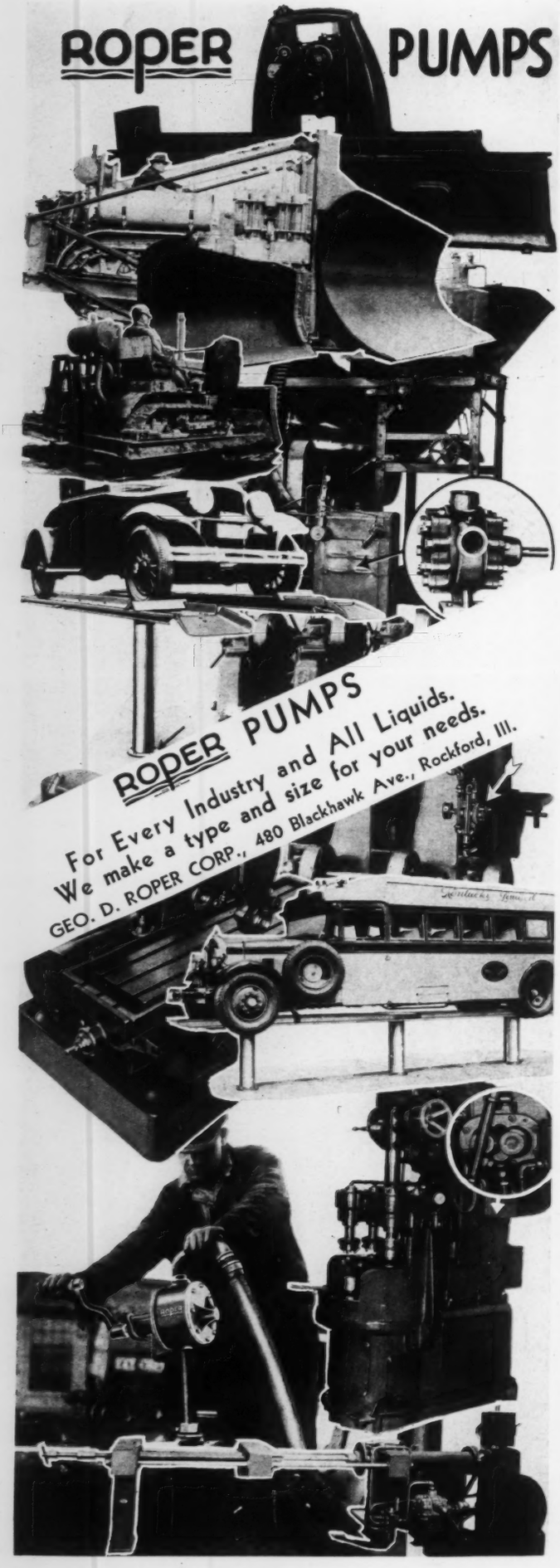
—another B. F. Goodrich Product

Texrope Belts are made by B. F. Goodrich for Allis-Chalmers. Complete stocks are carried in Allis-Chalmers warehouses all over the globe. When your belts finally need replacement the nearest Allis-Chalmers office will serve you promptly.

ORIGINATED BY ALLIS-CHALMERS
TEXROPE DRIVES
THE DRIVES THAT REVOLUTIONIZED TRANSMISSION PRACTICE • • •

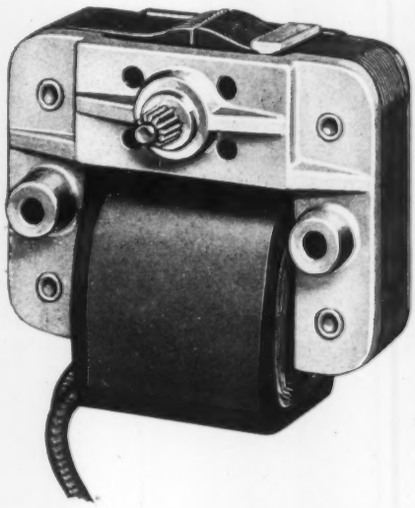





ROPER PUMPS
ROPER PUMPS
For Every Industry and All Liquids.
We make a type and size for your needs.
GEO. D. ROPER CORP., 480 Blackhawk Ave., Rockford, Ill.

ribbed boss is used for mounting the bearings, a construction said to prevent the shaft from becoming tight in the bearings due to being out of alignment.

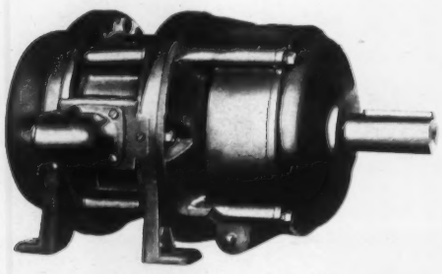
Cast bosses also are supplied to permit the motor to be mounted easily. A corrosion resisting steel with a hardened surface is used for the shaft which runs in oilless bearings. These motors, shown herewith, are supplied for voltages from 10 to 230 and frequencies from 25 to 60 cycles. They are said to be high in power output, and quiet in operation.



Small squirrel cage motor has shaft of corrosion resisting steel running in oilless bearings

Offers Gearmotors for all Uses

GEARMOTORS in a complete line, readily adaptable for application to machinery of widely varying designs, have been announced by General Electric Co., Schenectady, N. Y. The underlying principle of these gearmotors consists of a normal speed motor in combination with a built-in, internal helical, planetary gear speed reducer. Since this type of construction permits a wide choice of speeds on the output shaft, it is



Gear motor, typical of the smaller squirrel cage induction designs in the field of lower gear ratios

''THEY KEEP A-RUNNING''

1/6 Horse Power Century Type SP Split Phase Induction Motor

Maximum Protection
Against Dampness, Dust and Dirt

Just a glance at the external design of this Century Type SP Split Phase Induction Motor shows how the vital parts of the motor are protected against falling material, dirt, dust and dripping water—and why these motors are so widely used for many classes of service to which they are suited.

Their internal design meets each rigid Century requirement ...Their sturdy construction and clean-cut appearance immediately suggest ruggedness and "Keep-a-Running" ability in the machines on which they are mounted. ... Built in standard horse power ratings from 1/60 to 1/4.

Century MOTORS

CENTURY ELECTRIC COMPANY, 1806 Pine St., St. Louis, Mo.

Offices and Stock Points in Principal U. S., and Canadian Cities

SINGLE PHASE, THREE PHASE AND DIRECT CURRENT MOTORS · MOTOR GENERATOR SETS · ROTARY CONVERTERS · FANS AND VENTILATORS

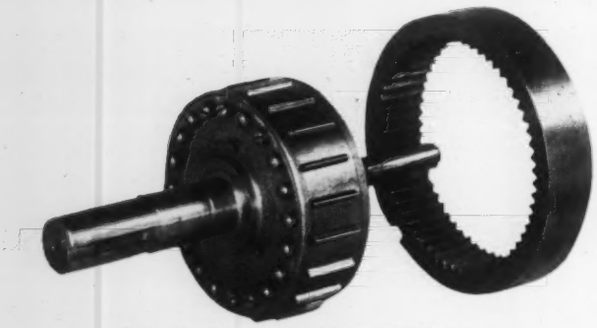
SP-1-1/4

FOR MORE THAN 28 YEARS AT ST. LOUIS

SPEED REDUCERS
that
Speed Up Business

Machine designers in every leading industry are finding a better solution for speed reduction problems by utilizing

HELIOCENTRIC
Speed Reducers



(The Heliocentric Reducer Element)

A distinctly different type of speed reducer . . . more compact . . . stands up under greater overload and overhung load . . . more readily adaptable to associated apparatus. Ratios from 20 to 1 to 1,000,000 to 1 in an exceptionally compact unit. Ratios starting at 4 to 1 in Universal Geared Reducers.

So outstanding is its performance that many electric motor manufacturers, also makers of agitators, hoists, mud-guns, water screens, conveyors and other special equipment, are incorporating the Universal Heliocentric Speed Reducer as an integral part of their apparatus.

Every machine designer in America should have a copy of this catalog in his file.

Send today for Heliocentric Catalog—No. 200 . . . 72 pages of valuable technical information.

UNIVERSAL GEAR
CORPORATION

SPEED REDUCERS
HELIOCENTRIC AND HELICAL

19th at Martindale **Indianapolis, Ind.**

Makers, also, of Motorized Speed Reducers, Variables, Clutches, etc.

possible to adapt a gearmotor to almost every type of low speed drive.

The company also offers gearmotors with special electrical characteristics, such as high starting torque with low starting current, normal starting torque with low starting current, adjustable, varying speed, multispeed, etc., or mechanical features such as totally enclosed; totally enclosed, fan cooled; or Class I, Group D, construction for use in hazardous locations where gas is present.

Alternating current, polyphase, squirrel cage and wound rotor gearmotors are available in ratings up to 75 horsepower, single phase to 5 horsepower, and direct current to 7½ horsepower. Direct current gearmotors are offered for those applications where either the advantages of adjustable speed drive or a direct current source of supply render their use desirable. Standard gearmotors can be had with shaft speeds down to 13 revolutions per minute.

Power Show Indicates Improvement

VIRTUALLY a confirmation of the reports of many firms that business is showing an improvement is the announcement that 293 manufacturers of power producing machinery, mechanical devices for power transmission, precision instruments for the control of combustion, pressure, volume, flow and other measurable entity, material handling equipment, heavy electrical machinery, etc., will stage exhibits in the forthcoming Tenth National Exposition of Power and Mechanical Engineering at Grand Central Palace, New York, during the week of December 5. This is coincident with the annual meeting of the American Society of Mechanical Engineers.

These manufacturers now are preparing exhibits. The large attendance of representatives which is expected from every state in the Union, as well as many foreign countries, will find among other things, helpful ideas and a deal of information and inspiration. During the past two years, the interval since the ninth exposition, a considerable amount of research work has been carried on and completed, the results of which will be one of the outstanding features of the show.

Edward G. Budd Mfg. Co., Philadelphia, has granted the United States Steel Corp. the rights to the Budd system of stainless steel construction, including its shot welding process. The process is to be used by the subsidiaries of the corporation.

20 years of HARD LABOR!

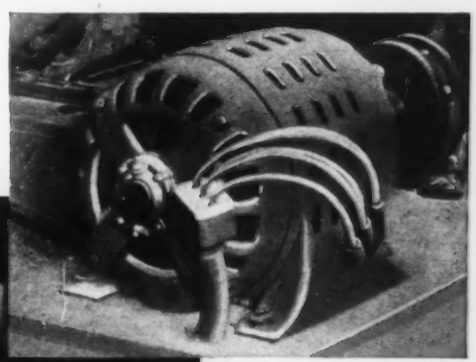
It was 1912 when two SKF Bearings dipped their pens in the ink of Performance and started to prepare this advertisement. It is not finished yet. You see, the bearings aren't . . . and 20 years have gone by.

For in 1912 these two SKF Bearings went into a Fairbanks Morse motor that in turn went into a St. Louis woodworking plant the very same year. The same old motor is still doing duty today on the same old pair of SKF Bearings.

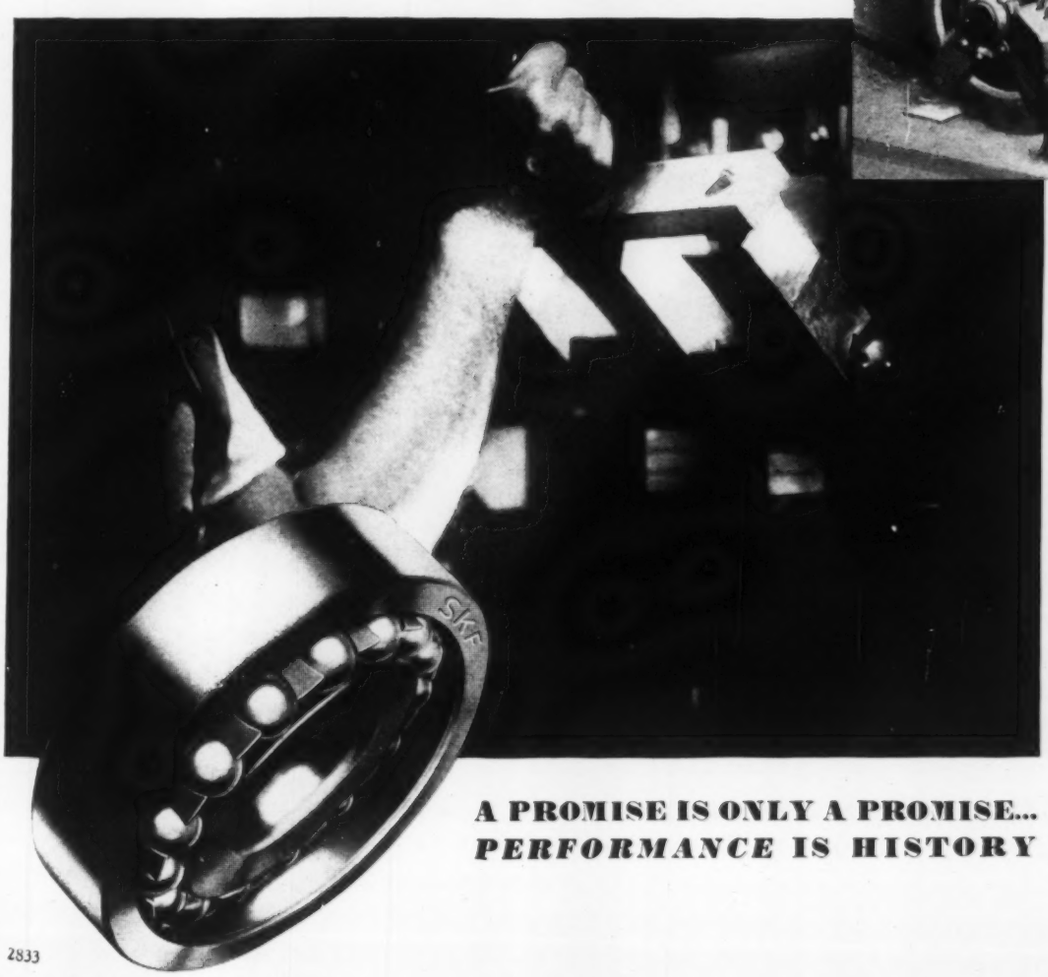
Perhaps ten years from now this pair of SKF Bearings, still functioning in the same Fairbanks Morse motor, will write another advertisement for SKF . . . SKF Industries, Inc. 40 East 34th Street, New York, N. Y.

● **Two SKF Bearings Began Writing This Advertisement in 1912**

SKF
BALL AND ROLLER BEARINGS



One of 50 SKF equipped Fairbanks Morse Electric Motors installed in a St. Louis woodworking plant in 1912.



A PROMISE IS ONLY A PROMISE...
***PERFORMANCE* IS HISTORY**

2833

Business and Sales Briefs

WALTER A. BLACK, formerly chief engineer of the Indianapolis works, Fairbanks-Morse & Co., has been named by Allen-Bradley Co., Milwaukee, manufacturer of electric controls, as manager of its Cleveland office at 942 Prospect avenue. John B. Vogel has been appointed manager of the Grand Rapids, Mich., office at 41 Grandville avenue, S. W.

* * *

James M. Dill, for the past 12 years manager of steel castings sales of the Erie Forge Co., Erie, Pa., has resigned to become manager of sales for the Erie Bolt & Nut Co.

* * *

Magnetic Mfg. Co., Milwaukee, is now represented in the Cincinnati territory by J. E. Harlow, with offices at 7 West Sixth street.

* * *

Lew E. Wallace is now district sales manager for Youngstown Sheet and Tube Co. with headquarters at New York. W. B. Blowers, former sales manager at New York, will continue in that office as special representative for the company.

* * *

Detroit Seamless Steel Tubes Co., Detroit, has added the following companies as mill supply distributors for its line of bushings: Topping Brothers, New York; Lewis E. Tracy Co., Boston; Charles C. Lewis Co., Springfield, Mass.; and E. C. Church Co., Providence, R. I.

* * *

James R. Mills, district sales manager at Cleveland for the Carnegie Steel, Illinois Steel and Tennessee Coal, Iron & Rail Cos, has been appointed district sales manager for all three companies at New York city. He succeeds Charles C. Cluff, who retired July 1 after 48 years affiliation with the steel industry.

* * *

Link-Belt Ltd., has removed its Montreal office and warehouse to 934 Inspector street.

* * *

Poole Foundry & Machine Co., Baltimore, manufacturer of flexible couplings, is now represented in western Pennsylvania, West Virginia and eastern Ohio by Ladd Equipment Co., First National Bank building, Pittsburgh.

* * *

Holo-Krome Screw Corp., formerly of Hartford, Conn., manufacturer of hollow head cap and safety set screws and pipe plugs has announced that its main office and factory are now located in Bristol, Conn.

* * *

Ohio Electric Mfg. Co., Cleveland, has appointed C. Sam Swanson, 1616 Kresge building, Detroit, its representative for the sale of fractional horsepower electric motors, 1/50 to 1 horsepower.

* * *

R. L. Shaw, for the past six years manager of the Milwaukee office of W. A. Jones Foundry & Machine Co., has been transferred to the main office and plant in Chicago, where he will handle sales and advertising.

* * *

Harry G. Porch, New England manager for Lukens Steel Co., with offices at 131 State street, Boston, will also be in charge of the new Boston headquarters of Lukenweld Inc., subsidiary of the Lukens Steel company with offices in the same building. Mr. Porch's assistant in the activities of Lukenweld in New England will be H. G. Austin.

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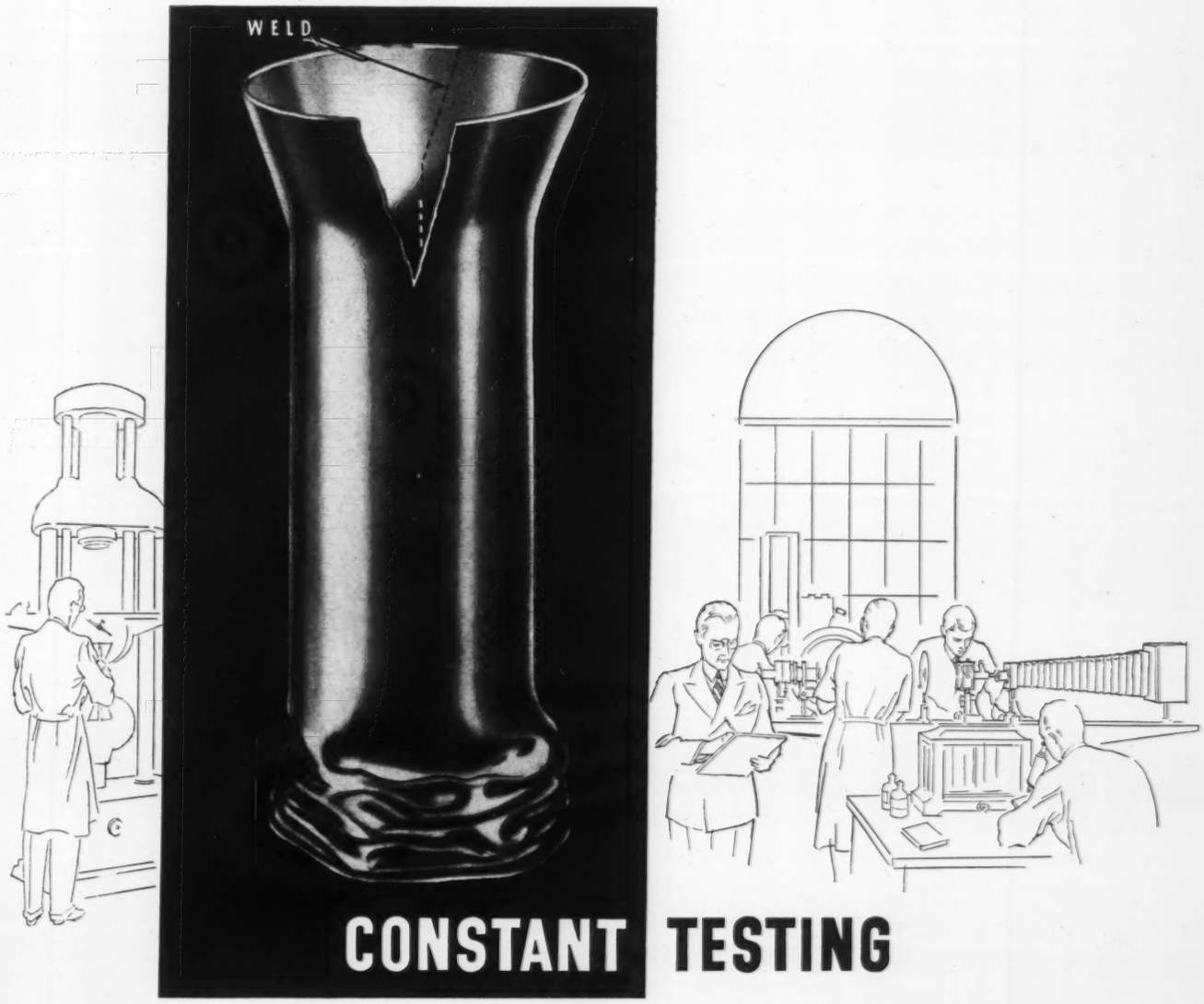

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